Developing a Brief and Valid Measure of Delay Discounting

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I declare that this report is my own original work and that contributions of others have been duly acknowledged.

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Tanya Wilson	Date

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Table of Contents

List of Tables

List of Figures

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Abstract

Delay discounting, the rate at which an individual devalues delayed rewards, is a potential neurobehavioural marker of substance use disorder. The Monetary Choice Questionnaire is a commonly used measure of delay discounting. It has good psychometric properties, such as good construct validity, test-retest reliability and limited ceiling effects. A drawback of the questionnaire currently limiting its use in clinical settings is that it is unnecessarily long and repetitive. The questionnaire comprises 27 questions: 9-items within each small ($25—$35), medium ($50—60) and large ($75—$85) delayed reward category. The current investigation aimed to develop a brief, valid and reliable version of the Monetary Choice Questionnaire. An additional aim was to assess if delay discounting was sensitive to acute alcohol intoxication. Of the thirteen brief scales that were developed and tested, a 9-item scale made up of the medium sized delayed rewards replicated the full questionnaire, differentiated people with high and low alcohol harms, according to the alcohol use disorders identification test, and demonstrated good test-retest reliability. The full questionnaire did not differentiate AUDIT groups and was significantly different over the test-retest period. With regards to the secondary aim, acute alcohol intoxication did not significantly affect delay discounting.

Most people prefer to receive rewards immediately but are willing to wait for rewards of greater value (Ainslie, 1975). The preference for immediate rewards and the devaluation of delayed rewards is a widespread phenomenon across human and non-human animal species (Reynolds, de Wit, & Richards, 2002). However, the excessive devaluation of delayed rewards is considered a maladaptive behaviour and is a feature of numerous impulse control disorders. Notably, it is associated with binge eating and obesity (Amlung, Petker, Jackson, Balodis, & MacKillop, 2016), internet gaming disorder (Tian et al., 2018), gambling (MacKillop et al., 2011), borderline personality disorder (Paret, Jennen-Steinmetz, & Schmahl, 2017) and attention-deficit hyperactivity disorder (Jackson & MacKillop, 2016). Delay discounting is of particular importance to substance use disorder (SUD). Individuals experiencing SUD persistently prefer the immediate rewards associated with drug use (e.g., freedom from withdrawal) and devalue the long-term rewards associated with abstinence (e.g., health, financial stability and quality of life). Research in this area has established that greater delay discounting is robustly associated with increased quantity and frequency of drug use, SUD severity and a greater risk of relapse (Amlung, Vedelago, Acker, Balodis, & MacKillop, 2017). Consequently, delay discounting provides a potential means for identifying individuals who are myopic about future consequences and in need of additional support and targeted treatment strategies.

Delay discounting (also referred to as intertemporal choice) is an index of impulsive choice that quantifies the depreciation of a reward as temporal proximity increases. Delay discounting tasks are operationalised through (an often hypothetical) choice between a small reward received immediately and a large reward received after a specified delay (Hinson, Jameson, & Whitney, 2003).

More broadly, impulsivity is characterised as a "predisposition toward rapid, unplanned reactions to internal or external stimuli without regard to the negative

consequences of these reactions, to the impulsive individual or others" (p. 1784, Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001). Thus, impulsivity is a multidimensional construct comprising numerous independent and related processes (Gullo & Potenza, 2014). Impulsive behaviours may be the result of increased or decreased motivation and may be both a precursor to and a result of substance use (Dalley & Robbins, 2017). The multidimensionality of impulsivity is widely agreed upon; however, there is less agreement as to the demarcation of its underlying constructs (Evenden, 1999).

Two dimensions commonly delineated in theories of impulsivity are impulsive action and impulsive choice. Impulsive action (or poor response inhibition) is concerned with the execution stage of a behaviour. Individuals high in behavioural disinhibition initiate behaviours before successful processing and evaluation has occurred and also have a decreased capacity to effectively inhibit a prepotent response once it has been initiated (Grant & Chamberlain, 2014). Impulsive action can be divided into two neurocognitive aspects, each of which uses different tasks to measure the subprocesses: motor disinhibition (Go/No-Go and Stop Signal tasks) and cognitive disinhibition (Stroop tasks) (MacKillop et al., 2016; Stevens et al., 2014). Individual differences in disinhibition appear to result from the functioning of the orbitofrontal cortex, anterior cingulate cortex and associated limbic, striatal and cortical connections (Horn, Dolan, Elliott, Deakin, & Woodruff, 2003).

Conversely, impulsive choice relates to the cognitive evaluation stage of a behaviour. Individuals high in impulsive choice have heightened sensitivity towards incentive cues, increased motivation to engage in approach behaviours and a tendency to repeat impulsive decisions despite suboptimal consequences (Christiansen, Cole, Goudie, & Field, 2012). Impulsive choice has been linked to an imbalance between two neural systems; that is, an overactive bottom-up, amygdala-striatum drive system and an underactive top-down control system of the prefrontal cortex (Bickel et al., 2007).

Some authors distinguish between two facets of impulsive choice: delay discounting and impulsive decision making (Stevens et al., 2014). Delay discounting paradigms quantify impulsive choice in relation to the subjective value attributed to a reward as time to receipt increases (Hamilton et al., 2015). Commonly used measures of discounting include the Monetary Choice Questionnaire (MCQ), the Experiential Discounting Task (EDT) and the Delay Discounting Task (DDT). Conversely, impulsive decision-making tasks use a choice between a conservative or a safe option and a more risky option. Impulsive decision-making tasks include the Iowa Gambling Task (IGT), the Cambridge Gambling Task (CGT) and the Balloon Analogue Risk Task (BART). Figure 1 provides an overview of the two dimensions of impulsivity.

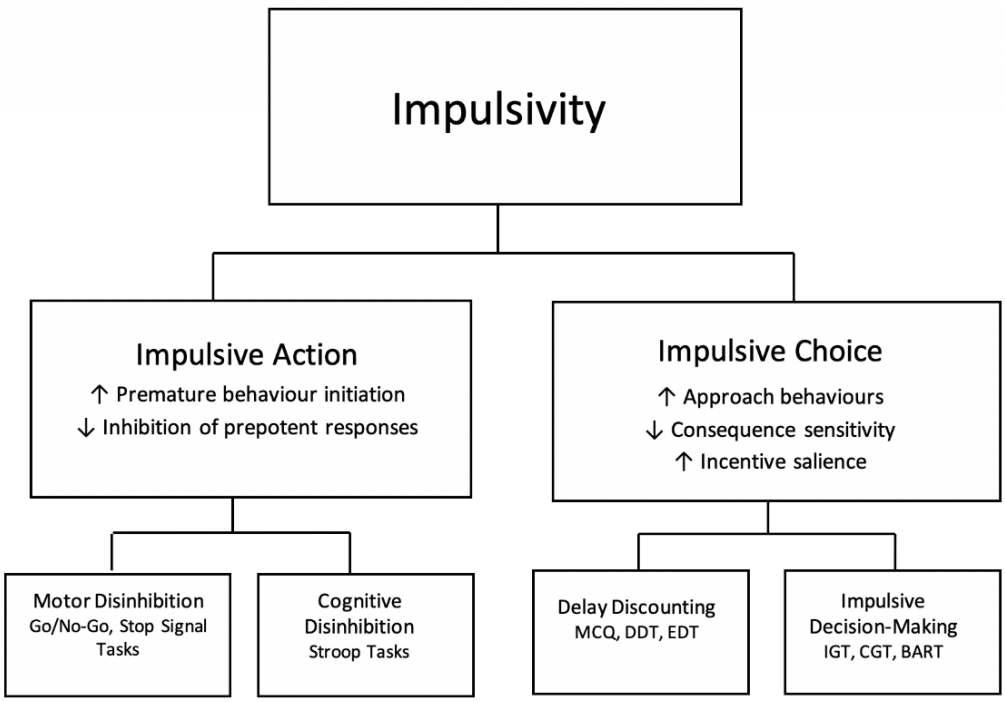

Figure 1. The two dimensions of impulsivity and their respective neurocognitive tasks, adapted from Stevens et al. (2014).

Extensive research has been undertaken that suggests that impulsive action and impulsive choice are independent processes of impulsivity. For example, Reynolds (2006) conducted a principal components analysis and observed that two measures of impulsive

action (the Stop Signal Task and the Go/No-go Task) were not significantly correlated with delay discounting ($r = –.04$, $r = –.08$, respectively) and loaded onto separate factors. Adopting a similar methodology, Dom, De Wilde, Hulstijn, and Sabbe (2007) observed distinct factor loadings for response inhibition and delay discounting tasks, and found that the correlation between the two behavioural measures was weak and non-significant ($r = .04$). Christiansen, Cole, Goudie and Field (2012) examined the independence of impulsivity measures and their association with hazardous drinking and found that delay discounting and response inhibition are associated with unique variances in hazardous drinking (as measured by the Alcohol Use Disorders Identification Test (AUDIT; Saunders, Aasland, Babor, de la Fuente, & Grant, 1993). Another study used the hedonic values of a sweet taste to examine reward sensitivity and found that participants who were higher delay discounters rated the sweet concentrations as being more enjoyable than participants who were shallow discounters (MacKillop et al., 2016). The study also showed that liking sweets was unrelated to impulsive action (as measured by a Go/No-Go task). Together, these findings suggest that impulsive action and impulsive choice are independent subprocesses of impulsivity.

Impulsive choice was first examined in the field of behavioural economics. A hybrid of economic and psychological disciplines, behavioural economics is primarily concerned with understanding rational and irrational decisions (Prelec & Loewenstein, 1991). Early proponents put forward the stationarity axiom of discounting, which stipulates that the preference of two respective rewards is unaffected by the delay to their receipt (Fishburn & Rubinstein, 1982). For example, if an individual values eating a piece of cake next Saturday three times more than the individual values eating a piece of fruit next Sunday, then the ratio of preference should be the same at various intervals of varying length. This theory resulted in exponential discounting models, under which the depreciation of value was calculated at a constant rate per unit of time (Kirby & Herrnstein, 1995). Conversely, hyperbolic models of

delay discounting are characterised by steep devaluation followed by a progressively slower rate of decay (Mazur, 1987). Recent research findings conducted across various populations, including populations of individuals suffering from SUD, have shown that hyperbolic models better fit delay discounting data in comparison to exponential models (Mellick, Tolliver, Brenner, & Prisciandaro, 2019). However, the debate continues as to which hyperbolic discounting function and number of free parameters fit the greatest variety of discounting choices (Myerson, Baumann, & Green, 2014). An example of exponential and hyperbolic discounting functions is presented in Figure 2.

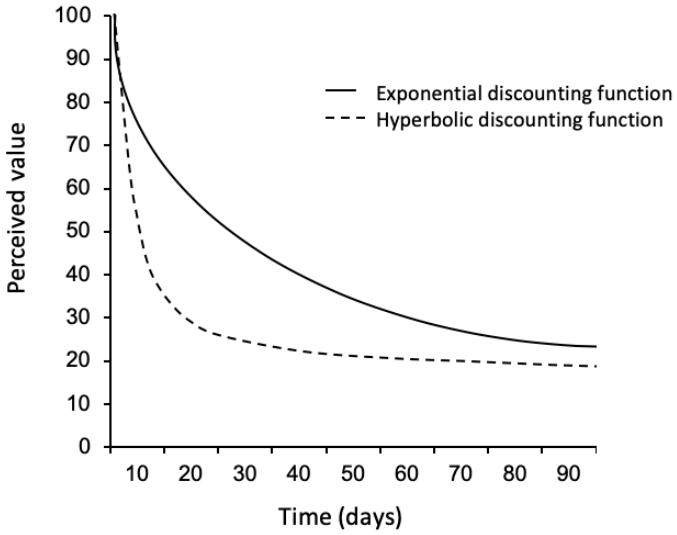

Figure 2. Exponential and hyperbolic discounting functions.

Note. The exponential discounting function has a constant rate of reward value decay over time, whereas the hyperbolic function is characterised by an initial steep devaluation, followed by a slower rate of decay.

The most commonly used single parameter hyperbola is expressed by the equation $V = A/(1+kD)$, where A is the non-discounted value of the reward and V is the present value of the reward at delay D, discounted at rate k (Kirby & Herrnstein, 1995). High k values are indicative of a steep discounting slope and increased impulsivity. While small k values are indicative of a shallower discounting slope that reflects reduced devaluation of the delayed reward and lower levels of impulsivity (see Figure 3 for examples of each of these discounting slopes). The point of indifference (PI) (i.e., the subjective equality between the

smaller immediate reward and the larger delayed reward) can be measured by manipulating the reward value and the delay. The subsequent plotting of numerous indifference points for different rewards and delays often leads to a hyperbolic (rather than an exponential) discounting slope.

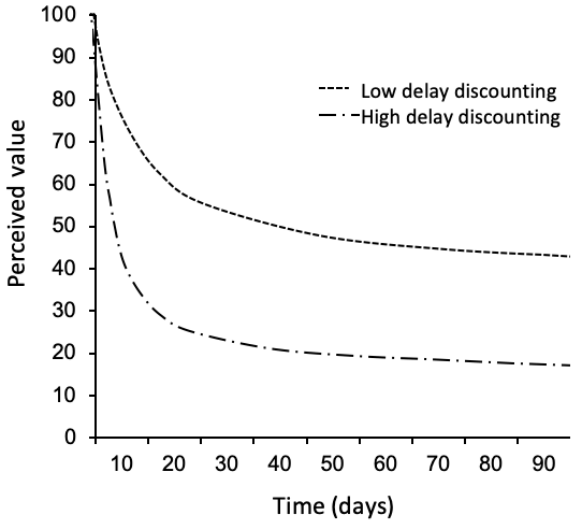

Figure 3. High and low discounting slopes, after Gray and MacKillop (2015).

Note: The steep delay discounting slope has an initial steep devaluation of the reward followed by a plateau. Conversely, the low discounting slope is more shallow which indicates that the perceived value of the delayed reward takes a longer amount time to depreciate.

Unlike exponential functions, hyperbolic discounting functions allow for preference reversal (Berns, Laibson, & Loewenstein, 2007). If the receipt of both a small and a large reward is delayed, the large reward is preferred due to its greater value; however, if the delay for the small reward is reduced to almost immediate receipt, a preference reversal occurs, whereby the perceived value of the small immediate reward is greater than that of the larger delayed reward (see Figure 4). Preference reversal is a common feature of SUD. For example, in relation to drugs, the positive long-term consequences of abstinence are suddenly devalued because of the immediate satiation of rewards associated with drug use (Bickel, Johnson, Koffarnus, MacKillop, & Murphy, 2014).

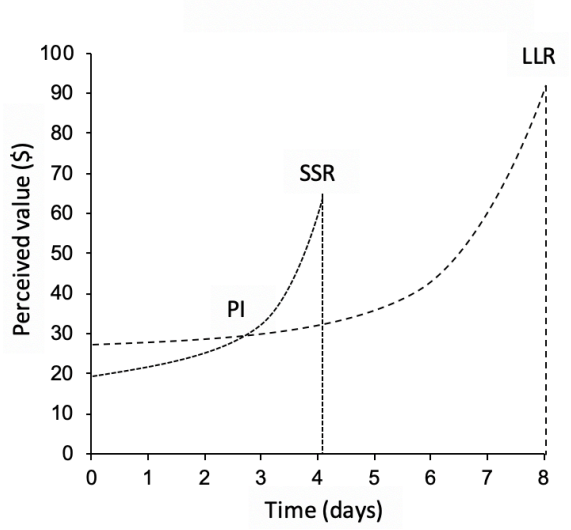

Figure 4. Discounting curves for two delayed rewards, after Kirby and Herrnstein (1995).

Note: The dotted lines, which represent the perceived value of each reward, increases as the time to delivery decreases. SSR indicates the time of receipt for the smaller sooner reward. LLR indicates the time of receipt for the larger later reward. The lager later reward is initially preferenced due to its greater value. The two hyperbolic slopes cross at the point of indifference (PI): where the perceived value of the smaller reward is equal to that of the larger later reward. After the PI, the smaller reward is preferred due to its almost immediate receipt while the larger reward is devalued due to the delay in its receipt.

SUD and alcohol use disorder (hereafter collectively referred to as SUD) are characterised by the misuse and abuse of licit or illicit substances resulting in impairment and distress (American Psychiatric Association, 2013). SUD is a chronic and relapsing condition, characterised by recurring stages of binging or intoxication, withdrawal and negative affect and preoccupation or craving (Koob & Volkow, 2010). Reduced executive functioning (e.g., steep delay discounting) is apparent among those suffering from SUD and is associated with poorer treatment outcomes (e.g., dropping out of treatment programs and relapsing) (Copersino et al., 2012). Executive functions refer to a group of top-down cognitive processes that require attention, control and strategic planning to achieve current goals (Wilens et al., 2011). The Addictions Neuroclinical Assessment (ANA) framework conceptualises the functioning of individuals experiencing SUD in relation to the domains of

impairment most prevalent at each stage in the cycle of dependence (Kwako, Momenan, Litten, Koob, & Goldman, 2016):

- *The dysfunction of cognitive control*: deficits related to attention, planning, working memory and temporal myopia (preoccupation/craving);
- *Incentive salience*: craving following exposure to drug-related cues (binging/intoxication); and
- *Negative emotionality*: drug taking as a result of tension reduction for anhedonia (withdrawal/negative affect).

Figure 5 provides an example of the relationship between the stages and related domains of impairment. The debate continues as to whether decision making (inclusive of delay discounting) should be an additional component of the ANA framework or whether it should be subsumed under the broader category of executive function and cognitive control (Verdejo-Garcia, 2017).

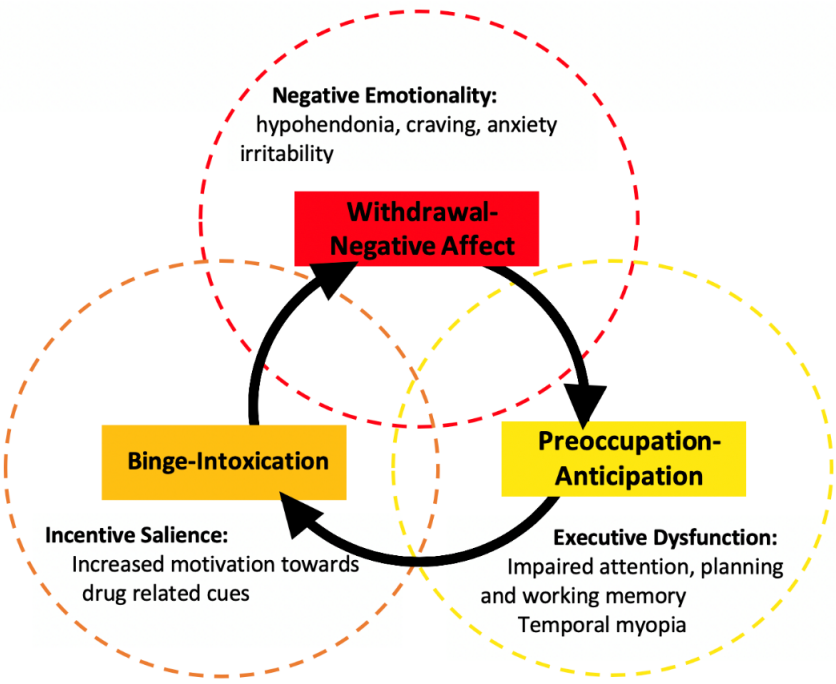

Figure 5. Stages and domains of impairment of substance use disorder, after Kwako et al. (2016).

Due to numerous risk and protective factors, only a small percentage of individuals who use substances develop a dependence or use disorder. However, those who do develop a dependence or use disorder, may experience reduced quality of life, hospitalisation, violence, neglect, incarceration and fatality (McLellan, 2017). In addition to the potential harm to the self and others, the healthcare costs, loss of revenue and crime associated with SUD carries an economic burden of $8.2 billion in Australia annually (Collins & Lapsley, 2008).

A large body of research has shown that high delay discounting is a feature of SUD. One such example is Madden, Petry, Badger and Bickel (1997)'s study investigating the discounting of hypothetical rewards between opioid-dependent and non-drug-dependent participants. The authors found that participants experiencing opioid dependence engaged in significantly greater discounting (i.e., demonstrated an increased preference for small immediate rewards) compared to controls. These findings have been replicated in other studies of populations experiencing dependence with opiates (Kirby, Petry, & Bickel, 1999; Vassileva, Georgiev, Martin, Gonzalez, & Segala, 2011), cocaine (Coffey, Gudleski, Saladin, & Brady, 2003; Mejía-Cruz, Green, Myerson, Morales-Chainé, & Nieto, 2016), nicotine (Amlung & MacKillop, 2014; Brady Reynolds, Leraas, Collins, & Melanko, 2009), methamphetamine (Hoffman et al., 2006; Monterosso et al., 2007) and alcohol (Bailey, Gerst, & Finn, 2018; Mackillop et al., 2010; Mellick et al., 2019) (see Table 1 for an overview of the respective effect sizes).

Discounting rates have also been shown to vary between types of drug users. Individuals experiencing cocaine-based SUD engage in significantly greater discounting than cannabis-dependent individuals (Mejía-Cruz et al., 2016). Individuals who smoke cocaine are higher discounters than those who are intranasal users (Reed & Evans, 2016) and individuals who use cocaine recreationally are more shallow discounters than those with a cocaine dependence (Hulka et al., 2014). Heroin and cocaine dependent individuals have higher

Table 1.

A Summary of Findings for Delay Discounting Between People Experiencing SUD and Controls, after MacKillop et al. (2011)

Study	Drug Group	Groups	Clinical	Group Ns	Discounting Measure	Delayed Amount	Discounting Index	p	d
Mackillop et al. 2010	Alcohol	High AUD symptoms vs. low AUD symptoms	Yes	15 vs. 14	Monetary Choice Questionnaire	$55 (mean)	*k*	.01	0.42
Mellick et al. 2019	Alcohol	Alcohol dependence vs. controls	Yes	28 vs. 27	Multi-item choice task	$100.00	*k*	.01	0.77
Bailey et al. 2018	Alcohol	Alcohol dependence vs. controls	No	78 vs 51	Multi-item choice task	$50.00	*k*	.01	0.53
Hoffman et al. 2006	Stimulant	Methamphetamine-dependent vs. controls	Yes	16 vs. 23	Multi-item choice task	$100	*k*	.02	0.82
Monterosso et al. 2007	Stimulant	Methamphetamine-dependent vs. controls	Yes	12 vs. 17	Monetary Choice Questionnaire	$55 (mean)	*k*	<.05	0.78
Coffey et al. 2003	Stimulant	Cocaine dependent individuals vs. controls	Yes	12 vs. 13	Multi-item choice task	$1,000	*k*	.04	1.12
Mejía-Cruz et al. 2016	Stimulant	Cocaine dependent vs. controls	Yes	77 vs. 40	Multi-item choice task	$200.00	AUC	.01	0.44
Mejía-Cruz et al. 2016	Stimulant	Cocaine dependent vs. controls	Yes	77 vs. 40	Multi-item choice task	$3000.00	AUC	< .01	0.52
Madden et al. 1997	Opiate	Heroin dependent vs. controls	Yes	18 vs. 38	Multi-item choice task	$1000.00	*k*	.01	0.49
Kirby et al. 1999	Opiate	Heroin dependent vs. controls	Yes	56 vs. 60	Monetary Choice Questionnaire	$55 (mean)	*k*	.01	0.57
Reynolds et al. 2009	Tobacco	Smokers vs. nonsmokers	No	15 vs. 15	Monetary Choice Questionnaire	$55 (mean)	*k*	.02	0.95
Baker et al. 2003	Tobacco	Smokers vs. nonsmokers	No	23 vs. 21	Multi-item choice task	$55 (mean)	*k*	.02	0.90

Note. Delayed amount represents the total or average value of the larger delayed reward within in each study. Discounting index represents the way in which discounting was calculated.

discounting rates than individuals with alcohol use disorder (Kirby & Petry, 2004). Individuals who share heroin needles engage in greater discounting than those who inject heroin but do not share needles (Odum, Madden, Badger, & Bickel, 2000). Among individuals with an opioid dependence, those who use heroin are steeper discounters than those who use prescription opioids (Karakula et al., 2016). Steep delay discounting is also robustly associated with SUD severity and the quantity and frequency of drug use. Specifically, an increased preference for immediate rewards was found to be associated with increased drug taking at hazardous levels and symptoms of SUD (Stevens et al., 2014). Together, these findings suggest that delay discounting rates vary depending on the type of substance, the method of consumption and the severity of dependence, such that riskier and more chronic forms are connected with greater discounting.

These findings are further supported by studies that have sought to document associations between discounting and treatment outcomes, such as relapse. Treatment outcomes are primarily indexed according to time in treatment and level of substance use following treatment. Research findings have consistently shown that time in treatment is positively associated with post-treatment outcomes (Laudet, Stanick, & Sands, 2009; Stevens et al., 2014). Steep delay discounting is also a significant predictor of shorter treatment retention. Stevens, Verdejo-García, Roeyers, Goudriaan, and Vanderplasschen (2015) observed that for every unit increase of natural logarithm transformed rates of discounting (ln *k*), the odds of prematurely leaving treatment were 3.04 times greater than the odds of finishing treatment. This finding has been replicated in other studies, which have shown that individuals who are steep discounters have a greater incidence of irregular treatment course due to relapse or premature drop out (Rupp et al., 2016). Some authors have observed that discounting rates decrease between pre- and post-treatment (Black & Rosen, 2011; Harvanko, Strickland, Slone, Shelton, & Reynolds, 2019). Others have observed that discounting is

higher in periods of mild opioid deprivation than in periods of opioid satiation (Giordano et al., 2002). The latter finding is consistent with the ANA's framework that suggests that withdrawal and cravings lead to an acute reward bias. Together, these findings suggest that steep discounting is linked with premature treatment drop out and that discounting reduces following abstinence, but only in conjunction with treatment.

Discounting is also indicative of treatment readiness. Specifically, high discounting rates are associated with a reduced intention to quit and lower abstinence self-efficacy (Athamneh et al., 2019; Athamneh, Stein, & Bickel, 2017). Similarly, other studies have shown that steep discounting is associated with reduced abstinence (Black & Rosen, 2011; Dallery & Raiff, 2007; Passetti et al., 2011; Sheffer et al., 2012; Stanger et al., 2012; Washio et al., 2011; Yoon et al., 2007). Some authors have failed to observe the aforementioned relationship (De Wilde, Verdejo-García, Sabbe, Hulstijn, & Dom, 2013; Krishnan-Sarin et al., 2007; Passetti, Clark, Mehta, Joyce, & King, 2008; Peters, Petry, LaPaglia, Reynolds, & Carroll, 2013); however, discounting is regarded as a relatively consistent predictor of abstinence (see Table 2 for the respective effect sizes; Stevens et al., 2014). The magnitude of the relationship between the two factors is dependent on the treatment program, the type of drug and the measure of discounting. The findings suggest that individuals with impaired delay discounting face substantial barriers to achieving and maintaining abstinence. Thus, discounting rates have the potential to be neurobehavioural markers for risk of relapse and consequently, can be used to identify individuals in need of additional support and treatment strategies.

In addition to being a possible antecedent of SUD, increased impulsive choice is theorised to be a consequence of acute alcohol intoxication (Bernhardt et al., 2019). However, research investigating delay discounting following an acute alcohol dose has failed to support this hypothesis. Adams, Attwood and Munafò (2017) observed that heavy drinkers

Table 2.

Steep Delay Discounting as a Predictor of Treatment Outcomes, after Stevens et al. (2014).

Outcome	Study	Drug Group	N	Discounting Measure	Delayed Amount	Discounting Index	p	d
Abstinence	Black and Rosen (2011)	Cocaine and alcohol dependent individuals	90	MCQ	$55 (mean)	*k*	0.04	NA
	Dallery and Raiff (2007)	Nicotine dependent individuals	30	DDT	$1000	AUC	<.05	1.05
	Peters et al. (2013)	Cannabis dependent individuals	93	EDT	$0.30	AUC	>.05	0.12
	Stanger et al. (2012)	Cannabis dependent adolescents	165	DDT	$1000	*k*	<.05	0.95
	Washio et al. (2011)	Cocaine dependent individuals	36	DDT	$1000	*k*	0.02	0.8
	Yoon et al. (2007)	Nicotine dependent pregnant women	48	DDT	$1000	*k*	0.02	0.71
	De Wilde et al. (2013)	Poly-substance use and alcohol dependence	37	DDT	$100	*k*	0.52	0.23
	Krishnan-Sarin et al. (2007)	Nicotine dependent adolescents	30	Multi-item choice task	$55 (mean)	*k*	0.06	0.07
	Krishnan-Sarin et al. (2007)	Nicotine dependent adolescents	30	EDT	$0.30	AUC	<.05	0.62
	Passetti et al. (2008)	Opiate dependent individuals	37	DDT	NR	*k*	>.05	0.36

Outcome	Study	Drug Group	N	Discounting Measure	Delayed Amount	Discounting Index	p	d
Abstinence Self-efficacy	Passetti et al. (2011)	Opiate dependent individuals	80	DDT	NR	*k*	<.05	0.53
	Sheffer et al. (2012)	Nicotine dependent individuals	97	DDT	$1000	*k*	0.04	0.23
	Athamneh et al. 2019	Previous substance dependent individuals in recovery	227	Multi-item choice task	$1000	*k*	<.001	0.85
	Athamneh et al. 2017	Nicotine dependent individuals	384	Multi-item choice task	$1000	*k*	0.005	NR
	Peters et al. (2013)	Cannabis dependent individuals	93	EDT	$0.30	AUC	0.03	0.45
Duration in Treatment	Stevens et al. 2015	Substance dependent individuals	84	DDT	$1000.00	*k*	0.02	0.95
	Rupp et al. 2016	Alcohol dependent individuals	43	DDT	$1000.00	*k*	0.05	0.67

Note. AUC = area under the curve. NR = not reported. Delayed amount represents the total or average value of the larger delayed reward within in each study. Discounting index represents the way in which discounting was calculated.s

had significantly higher discounting rates than light drinkers, but that an acute alcohol dose had no effect on discounting relative to the placebo condition, for both categories of drinkers (0.4g/kg In: light: $d = .63$; heavy: $d > .001$; 0.6 g/kg In: light: $d > .001$; heavy: $d > .001$). Notably, the majority of studies have observed similar results; that is, that acute alcohol dose had no significant effect on delay discounting (Bernhardt et al., 2019; Bidwell et al., 2013; Johnson, Sweeney, Herrmann, & Johnson, 2016; Richards, Zhang, Mitchell, & de Wit, 1999) (see Table 3). Conversely, Reed, Levin, and Evans (2012) used the Monetary Choice Questionnaire to investigate discounting between heavy and light female drinkers, during periods of sobriety and acute alcohol intoxication. The authors observed a small significant dose effect between the placebo, 0.50 and 0.75g/kg alcohol conditions ($d = .35$), which suggests that the MCQ may be sensitive to the effect of acute alcohol intoxication on discounting.

It has been argued that working memory plays a critical role in the relationship between SUD, executive dysfunction and delay discounting due to compromising the retention of optimal but less salient information when processing goal-directed behaviours (Bobova, Finn, Rickert, & Lucas, 2009). Wesley and Bickel (2014) conducted a meta-analysis using activation likelihood estimations to map areas of brain activation and observed similar patterns of activation for tasks related to delay discounting and working memory. Their analysis revealed an overlap in limbic, striatal, insula and cingulate areas of the brain with a pronounced shared cluster in the left lateral prefrontal cortex. It has been argued that this area of the cortex plays a role in decision-making processes that require weighing positive and negative consequences (Davidson & Irwin, 1999). Numerous studies have observed that increasing working memory load leads to greater delay discounting, and that

Table 3.

Summary of Findings for Delay Discounting Rates During Acute Alcohol Intoxication

Study	Groups	Group Ns	Alcohol Dose	Delay Discounting Measure	Delayed Amount	Discounting Index	p	d
Adams et al. 2017	Light social drinkers	17	.00, .40 g/kg	Multi-item choice task	$20.00	*k*	>.20	0.63
Adams et al. 2017	Light social drinkers	16	.00, .60 g/kg	Multi-item choice task	$20.00	*k*	>.20	0.00
Adams et al. 2017	Heavy social drinkers	15	.00, .40 g/kg	Multi-item choice task	$20.00	*k*	>.20	0.00
Adams et al. 2017	Heavy social drinkers	16	.00, .60 g/kg	Multi-item choice task	$20.00	*k*	>.20	0.00
Bernhardt et al. 2019	Male social drinkers 18-19 years	54	aBACs 0, 80 mg%	Multi-item choice task	$10.00	*k*	.55	0.05
Bidwell et al. 2013	Non-alcohol dependent	60	.00, .40 mg/dl	Multi-item choice task	$100.00	AUC	.80	0.09
Bidwell et al. 2013	Non-alcohol dependent	60	.00, .80 mg/dl	Multi-item choice task	$100.00	AUC	.34	0.19
Johnson et al. 2016	Non-alcohol dependent	23	.00, 1 g/kg	Multi-item choice task	$100.00	AUC	.18	N/A
Reed et al. 2012	Female light and heavy drinkers	23	.00, .50, .75 g/kg	Monetary Choice Questionnaire	$85.00	*k*	.03	0.37
Reynolds et al. 2006	Social drinkers	24	.00, .80 g/kg	Multi-item choice task	$10.00	*k*	.94	0.01
Richards et al. 1999	Non-alcohol dependent	24	.00, .50 g/kg	Multi-item choice task	$10.00	AUC	.27	0.34
Richards et al. 1999	Non-alcohol dependent	24	.00, .80 g/kg	Multi-item choice task	$10.00	AUC	.97	0.01

Note: Delayed amount represents the total or average value of the larger delayed reward. Discounting index represents how discounting is calculated. Reed et al. 2012 reported a dose effect of increased discounting between .00, .50 and .75 g/kg but did not report pairwise comparisons between each dose pair.

reduced working memory capacity is associated with greater discounting (Finn, Gunn, & Gerst, 2014; Hinson et al., 2003). However, working memory training has had only limited success in reducing discounting rates. Notably, it has been found to lead to a reduction in discounting rates in stimulant users (Bickel, Yi, Landes, Hill, & Baxter, 2011) but not in opiate users (Rass et al., 2015). Thus, working memory and delay discounting appear to share a functional overlap related to maintaining the information necessary to evaluate consequences of intertemporal decisions; however, more research needs to be conducted to further explore the connection between the two processes.

Cognitive impairments apparent during SUD (e.g., steep delay discounting and reduced working memory capacity) are associated with reduced treatment outcomes (e.g., dropping out of treatment programs and relapsing) (Copersino et al., 2012). Predictors of poor treatment outcomes can be used to develop tailored treatment plans to address individual levels of cognitive impairment (Goudriaan, Oosterlaan, De Beurs, & Van Den Brink, 2008). For example, individuals suffering from SUD with high levels of impulse choice have better outcomes if they engage in residential community treatment programs rather than in counselling-based therapy programs (Passetti et al., 2011). Commonly used predictors of treatment outcomes include sociodemographic, psychological and clinical factors (Reske & Paulus, 2008). Due to its robust associations with treatment outcomes and therapeutic change mechanisms, cognitive assessment is increasingly being used as a predictor of treatment outcomes (Copersino et al., 2012; Verdejo-García et al., 2012).

Currently, the most widespread cognitive test batteries are prohibitively resource consuming. Such measures take 60 to 90 minutes to complete and must be administered face-to-face by qualified testers, who are rare in the SUD treatment workforce (Collins, 2018). Further, as they have been developed on populations comprising individuals who do not suffer from SUD, such measures lack construct and ecological validity. Consequently, the

measures focus heavily on domains unrelated to substance dependence and neglect those (such as impulsive choice) that are related to SUD (Verdejo-García et al., in press). Measures used to predict treatment outcomes and improve individualised treatment plans need to be accessible, have good construct and ecological validity and be relatively easy to administer, score and interpret.

The MCQ (Kirby, Petry & Bickel, 1999) is one of the most popular tools used to measure delay discounting (Kaplan et al., 2016). This open-access tool is available in both computerised and pencil-and-paper versions and takes approximately eight minutes to complete. Overall, the MCQ has demonstrated good psychometric properties across a range of clinical and non-clinical populations (Nguyen, Brooks, Bruno, & Peacock, 2018). It has good test-retest reliability, internal consistency and limited floor and ceiling effects (Hamilton et al., 2015). It also has good construct validity. Indeed, compared to non-drug-dependent controls, individuals experiencing dependence with alcohol, cannabis, opiates and cocaine have consistently shown steeper delay discounting (Myerson et al., 2014). Some authors have questioned the ecological validity of hypothetical delay discounting measures for which the hypothetical rewards have low incentive salience and the participants do not experience the consequences of their decisions (Nguyen et al., 2018). There have been observations of small significant effects of reduced impulsivity between discounting of real, in comparison to hypothetical rewards (Hinvest & Anderson, 2010); however, overall, the findings in the literature suggest near empirical equivalence (Matusiewicz, Carter, Landes, & Yi, 2013).

The MCQ comprises 27 hypothetical choices between small immediate rewards and larger delayed rewards (Kirby et al., 1999). The value of the reward and the time to receipt vary from $11–$85 and 0–160 days, respectively. Under the magnitude effect, smaller rewards are consistently discounted more steeply than larger rewards (Green & Myerson,

2004). The MCQ is scored by matching participants' response patterns to one of nine categories of predicted rates (or *k* values) based on the highest consistency of their reward choices (Gray, Amlung, Palmer, & MacKillop, 2016). The 27-items of the MCQ and the associated *k* value is provided in Table 4. Chosen *k* values represent individual hyperbolic discounting functions and the point of indifference (Yoon et al., 2017). The categories range from 0.25 (a value that represents an individual who consistently chooses smaller immediate rewards) to 0.00016 (a value that represents an individual who shows a consistent preference for larger delayed rewards). An individual assigned a *k* value of 0.041 would value $22 today the same as $100 in 85 days. Conversely, an individual assigned a *k* value of .0004 would value $74 today the same as $100 in 85 days. Thus, high *k* values indicate steep discounting or a greater devaluation of delayed rewards.

The full questionnaire can be divided into three groups of nine questions: containing small ($25, $30 and $35), medium ($50, $55 and $60) or large amounts ($75, $80 and $85). The questions in each category of reward values contain nine logarithmically spaced *k* values. It has been proposed that these value category scales represent alternative short forms of the full questionnaire (Myerson et al., 2014); however, this has yet to be empirically tested.

Despite good psychometric properties, the MCQ takes roughly eight minutes to complete, the most common scoring method requires a comprehension of a hyperbolic discounting function and excludes participants with missing or inconsistent responses (which characteristic of long questionnaires). The present study sought to address the current issues related to effective use in clinical settings, by developing and validating a brief version of the MCQ. The full 27-item MCQ was compared to numerous brief versions of the scale. Specifically, the construct and predictive validity with the AUDIT, test-retest reliability and concurrent and divergent validity (for working memory and response inhibition, respectively) of the brief versions of the scale were compared with the full MCQ. An additional aim was to

investigate the MCQ's sensitivity to alcohol intoxication.

Table 4.

Items of the Monetary Choice Questionnaire, Grouping and Rank in Each Value Category and Associated k Values

Order	Question	Group	*k*
13	Would you prefer $34 today, or $35 in 186 days?	Q1_1	0.00016
20	Would you prefer $28 today, or $30 in 179 days?	Q1_2	0.0004
26	Would you prefer $22 today, or $25 in 136 days?	Q1_3	0.001
22	Would you prefer $25 today, or $30 in 80 days?	Q1_4	0.0025
3	Would you prefer $19 today, or $25 in 53 days?	Q1_5	0.006
18	Would you prefer $24 today, or $35 in 29 days?	Q1_6	0.016
5	Would you prefer $14 today, or $25 in 19 days?	Q1_7	0.041
7	Would you prefer $15 today, or $35 in 13 days?	Q1_8	0.1
11	Would you prefer $11 today, or $30 in 7 days?	Q1_9	0.25
1	Would you prefer $54 today, or $55 in 117 days?	Q2_1	0.00016
6	Would you prefer $47 today, or $50 in 160 days?	Q2_2	0.0004
24	Would you prefer $54 today, or $60 in 111 days?	Q2_3	0.001
16	Would you prefer $49 today, or $60 in 89 days?	Q2_4	0.0025
10	Would you prefer $40 today, or $55 in 62 days?	Q2_5	0.006
21	Would you prefer $34 today, or $50 in 30 days?	Q2_6	0.016
14	Would you prefer $27 today, or $50 in 21 days?	Q2_7	0.041
8	Would you prefer $25 today, or $60 in 14 days?	Q2_8	0.1
27	Would you prefer $20 today, or $55 in 7 days?	Q2_9	0.25
9	Would you prefer $78 today, or $80 in 162 days?	Q3_1	0.00016
17	Would you prefer $80 today, or $85 in 157 days?	Q3_2	0.0004
12	Would you prefer $67 today, or $75 in 119 days?	Q3_3	0.001
15	Would you prefer $69 today, or $85 in 91 days?	Q3_4	0.0025
2	Would you prefer $55 today, or $75 in 61 days?	Q3_5	0.006
25	Would you prefer $54 today, or $80 in 30 days?	Q3_6	0.016
23	Would you prefer $41 today, or $75 in 20 days?	Q3_7	0.041
19	Would you prefer $33 today, or $80 in 14 days?	Q3_8	0.1
4	Would you prefer $31 today, or $85 in 7 days?	Q3_9	0.25

The first study aimed to develop numerous brief 5–9-item versions of the MCQ from the 27-item full questionnaire, measure the information retained using Item Response Theory and assess the newly developed scales' ability to replicate the full questionnaire and differentiate between individuals with high and low levels of hazardous alcohol use (as measured by the AUDIT). The three groups of delayed reward amounts (small, medium and large; each with nine items) were also tested in order to establish if they were reliable and valid short forms of the full MCQ. Specifically, the first study aimed to develop brief versions of the MCQ that replicated the full MCQ, as evidenced by overlapping 95% confidence intervals of overall logarithm transformed discounting rates (logk) and large significant correlations between the brief and full MCQ scales. It was hypothesised that participants with high AUDIT scores would engage in significantly greater discounting (as measured by logarithm transformed *k* values) than participants with low AUDIT scores, across each of the newly developed versions of the MCQ.

The second study used an independent sample to validate the newly developed versions of the scale. Temporal stability was measured over a one-week period. Concurrent validity with working memory and divergent validity with response inhibition were also explored. It was hypothesised that both the full MCQ and the brief MCQ scales would have good test-retest reliability (as evidenced by strong significant correlations of logk values between test and retest, visual inspection of score stability, non-significant t-tests and a Bayes factor greater than three for good evidence in favour of the null hypothesis of no change). It was also hypothesised that the logk values would be (moderately to strongly) negatively correlated with working memory performance as indexed by the N-back task (i.e., as discounting rates increased, the percentage of correct responses would decrease and reaction times would increase), due to previous studies identifying a moderate negative relationship between the two processes (Bickel et al., 2011). It was also hypothesised that discounting (as

measured by the logk values) would be (weakly) negatively correlated with response inhibition performance as indexed by the Stop Signal Task (i.e., as discounting increased, the percentage correct inhibit responses would decrease and reaction times would increase), in line with previous studies documenting weak negative correlations between the two processes (Dom et al., 2007).

The third study sought to investigate the full and brief MCQ scales' sensitivity to acute alcohol intoxication. Based on the findings of Reed et al. (2012), it was hypothesised that delay discounting rates (as measured by the logk values of the MCQ scales) would be significantly greater at 0.08% BrAC in comparison to the baseline and 0.05% BrAC on the descending limb.

Method Study 1: Development of Brief MCQ Scales

Participants

The *pilot dataset* comprised a sample of 518 Australian participants, aged between 18–35 years who had consumed alcohol in the past month. The dataset was collected for a thesis project, which was conducted at the University of New South Wales in 2017. Participants were recruited through online and on-campus advertisements, and asked to complete an online, fifteen-minute survey that was conducted through Research Electronic Data Capture (REDcap). Ethics approval was obtained from the Human Research Ethics Committee (H0018064; Appendix A).

The *validation dataset* comprised 170 Australian participants aged 18 years and over who had consumed alcohol in the last month. The author recruited the participants through Prolific Academic, a research recruitment website, in 2019. Ethics approval was obtained from the Human Research Ethics Committee (HC16915; Appendix C).

Materials

The MCQ was used as a measure of delay discounting (Kirby et al., 1999). The

participants were asked a series of hypothetical questions in which they had to choose between a smaller amount of money to be received immediately or a larger amount of money to be received after a specified delay. For example, in one question, the participants were asked: 'Would you prefer $55 today or $75 in 61 days?' Rewards ranged from $11 to $85 and delays ranged from 7 to 186 days. The 27-item questionnaire contained three categories based on the size of the delayed reward: small ($25–$35), medium ($50–$60) and large ($75–$85), each with nine items. The full MCQ is scored by matching participants' response patterns to one of nine categories of predicted discounting rates (or *k* values) based on the highest consistency of their reward choices. If two *k* values share the highest proportion, a geometric mean is taken between the two. Due to the smaller number of possible *k* values, the brief scales were scored based on the geometric mean of reward choices. Delay discounting rates were calculated by entering the participants' individual reward preferences into Kaplan's automated scoring spreadsheet (Kaplan et al., 2016).

The AUDIT (Saunders et al., 1993) is a 10-item questionnaire that assesses alcohol consumption, behaviours and associated problems. Higher scores indicate more hazardous alcohol consumption. Scores greater than eight indicate hazardous alcohol use, while scores greater than 16 are indicative of possible alcohol dependence. The AUDIT was used to investigate the predictive and construct validity of the full and brief versions of the MCQ.

Procedure

Participants in both the pilot and the validation study completed the online survey and were compensated for their time by having their names entered into a raffle and by monetary reimbursement, respectively.

Data Analysis

Cleaning: There were three instances of single item missing data in the pilot dataset in relation to the AUDIT data. In order to avoid loss of data through listwise

deletion, multiple imputation using LISREL 8.0 (Jöreskog & Sörbom, 1996) was performed to determine reasonable values for the missing items. The software uses an Expected Maximization (EM) algorithm in order to find response patterns in the data that match the cases missing an item.

Scale Reduction: Brief scales were developed using the pilot dataset of n = 518. Item-Response Theory (IRT) analyses were conducted to identify potentially redundant items. IRT requires a unifactorial latent structure to be validly applied. This was confirmed by undertaking a confirmatory factor analysis (CFA) of the 27-item MCQ using MPlus (Muthén, 2018). Model fit was evaluated based on root mean square error of approximation (RMSEA; good fit < .08), comparative fit index (CFI; good fit ≥ .90) and the Tucker Lewis Index (TLI; good fit ≥ .95) (Browne & Cudeck, 1992; Hu & Bentler, 1999). Given the binary nature of the MCQ items, a dichotomous (two parameter, 2PL) item parameter calibration was conducted using Xcalibre 4.2.2.0 (Assessment Systems Corporation, 2014). Choices in relation to item removal were assessed by considering the Test Information Function and Item Information plots. These plots provided quantity of information (precision) against Θ (scores on the latent structure of the scale; i.e., the degree of discounting) for each item and for the full scale. These plots effectively reveal redundant items that provide similar amounts of information at similar values of Θ. Items were retained based on the amount of information provided across the Θ spectrum to ensure an even spread of possible discounting rates and limited ceiling effects for extremely high discounters, which are the likely characteristics of the substance consuming population.

Kappa (*k*) values for each participant under each model were logarithm transformed to match the requirements of inferential statistical analyses. Test scales were compared using 1) the correlations between the test and original full model estimated logk values; 2) the

means and 95% confidence intervals (CIs) of the test and the original full model logk values; 3) information about the model's ability to differentiate between high (≥ 16) and low (< 16) scores on the AUDIT. These analyses were conducted separately on both the pilot and the validation datasets to ensure robustness.

Study 1: Results

Item-Response Theory Analyses of the Monetary Choice Questionnaire

IRT requires that the scales be unidimensional for analysis. CFA was used to confirm the unidimensionality of the MCQ [$\chi^2(324) = 640.58$, RMSEA = .04, CFI = .98, TLI = .99]. After inspecting item redundancy in the Test Information Plots by considering the possible *k* values in substance use, 10 brief versions of the MCQ were developed for testing (Figures 6.1—6.14. shows the TIF plots and Table 5 lists the items used in each model). The 10 brief versions included three brief scales of six items or less, which were developed from each of the small, medium and large categories of the MCQ and seven composite scales of seven items or less, which were developed from two or three value categories.

The subsequent inferential analyses used logk transformed values. The 10 newly developed scales were compared with the baseline 27-item MCQ and the three baseline, 9-item value category scales (small, medium and large). A visual inspection of means and 95% CI logk values revealed three scales replicated the full MCQ (see Figures 7.1—7.2.); *medium category, large brief* and *composite seven scales*. The scales that replicated the full MCQ were used in subsequent analyses. The scales that did not replicate the full MCQ were deemed inadequate and were not analysed further. A correlational analysis of the overall discounting logk revealed strong, significant positive correlations between the full MCQ and the test scales in both datasets (see Table 6).

The descriptive statistics for the high and low AUDIT groups for each model are presented in Table 7. Independent sample t-tests were used to identify which scales were

able to differentiate between high (≥ 16) and low scores (< 16) on the AUDIT (see Table 8). In relation to the pilot sample (n = 541), the full MCQ did not reveal any logk discounting differences between the high and low AUDIT groups (p = .06, d = .31). Moreover, no statistically significant effect was observed for the large brief (p = .07, d = .30) and composite 7 (p = .24, d = .19) scales. Interestingly, only the medium category scale identified significantly greater discounting in the high relative to the low AUDIT group (p = .02, d = .38). There was no significant effect of AUDIT group across any of the scales in the validation sample (full MCQ: p = .12, d = .39; large brief: p = .17, d = .35; composite 7: p = .12, d = .40), however the medium category scale achieved the largest effect size, which was of medium magnitude (p = .06, d = .48).

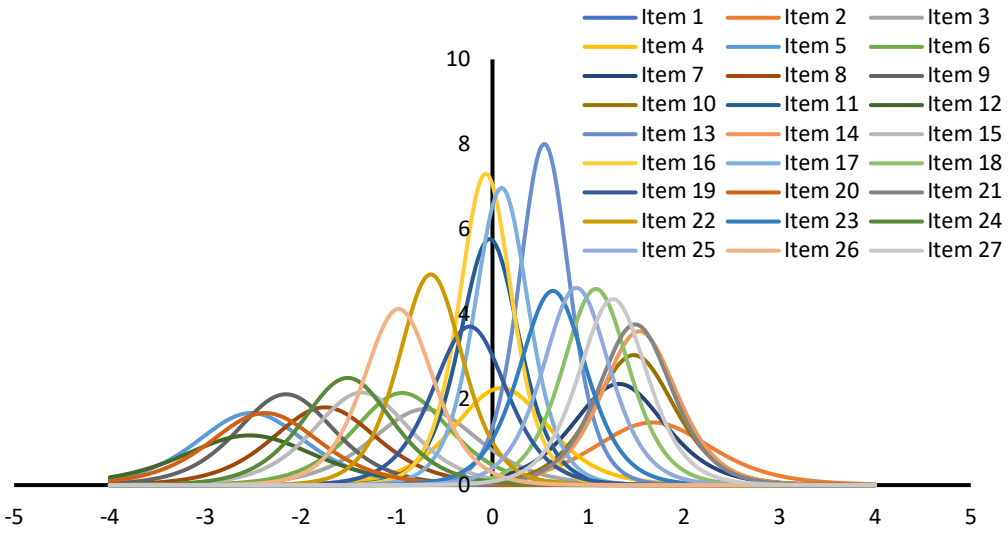

Figure 6.1. Full 27-item MCQ.

Figures 6.1–6.14. Plots of the MCQ items showing information against Θ on the y axis and degree of discounting (in terms of standard deviations above and below the mean) on the x axis.

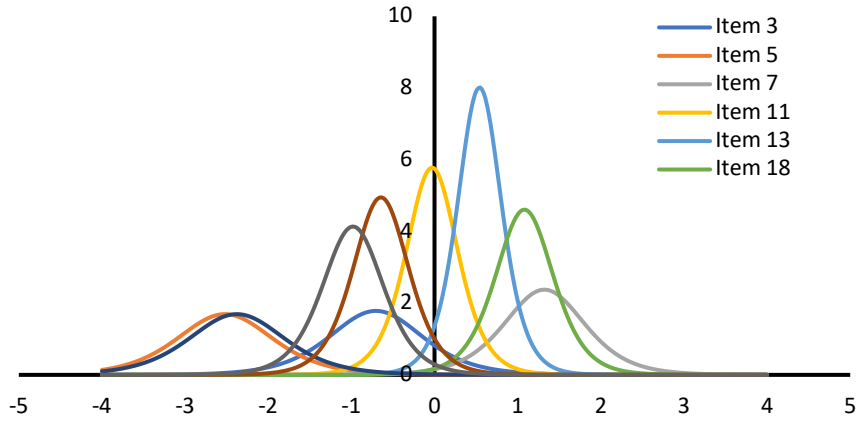

Figure 6.2. Small category scale.

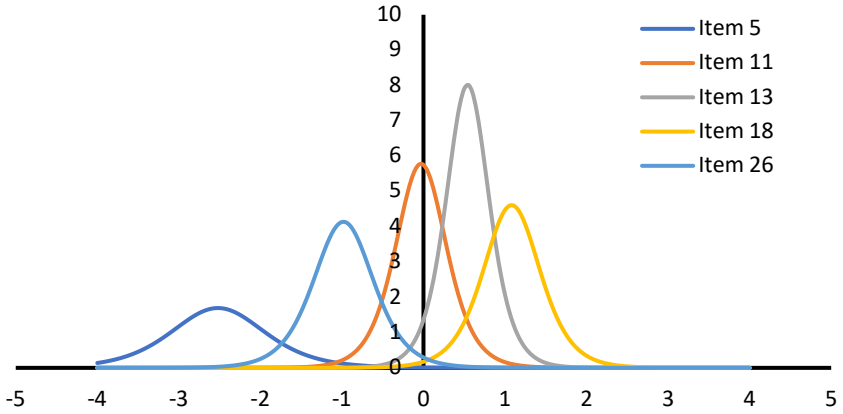

Figure 6.3. Small brief scale.

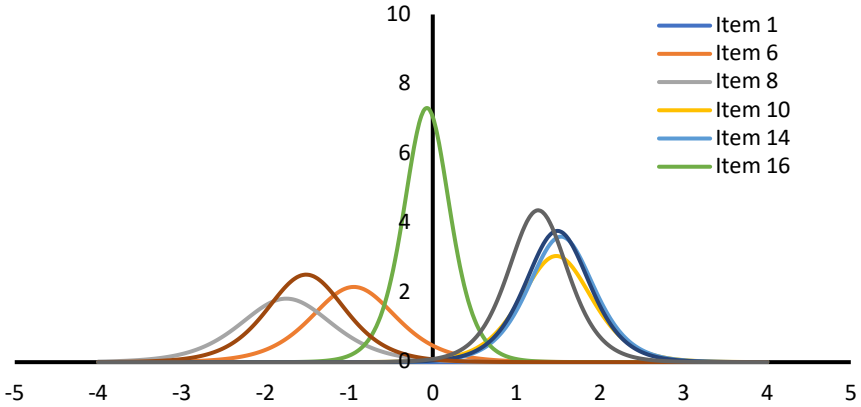

Figure 6.4. Medium category scale.

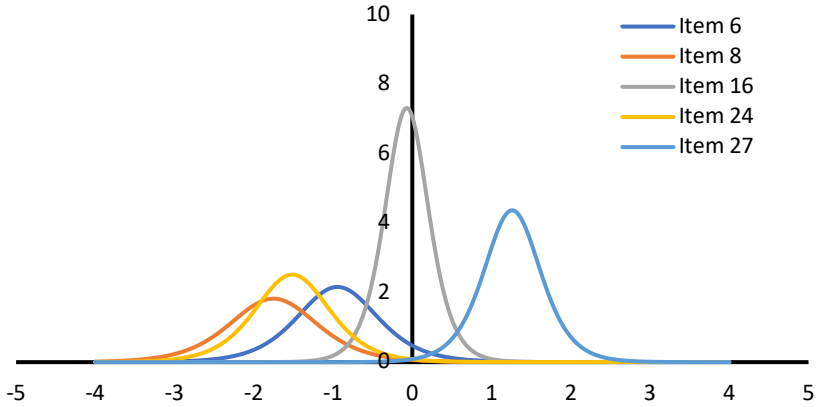

Figure 6.5. Medium brief scale.

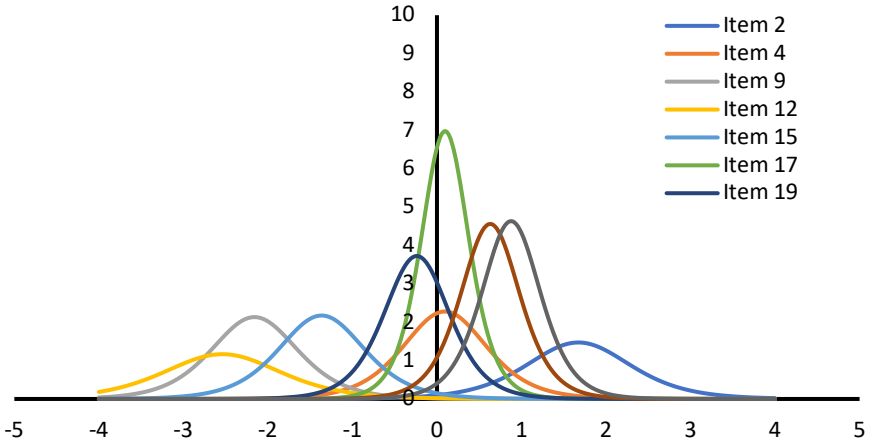

Figure 6.6. Large category scale.

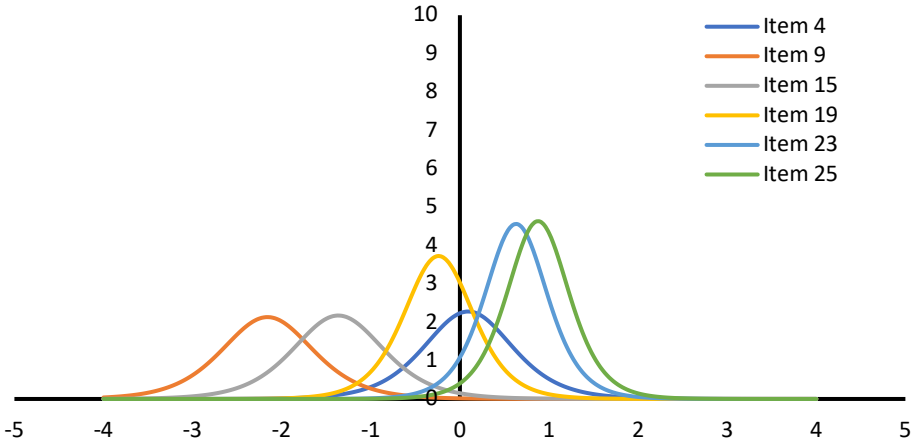

Figure 6.7. Large brief scale.

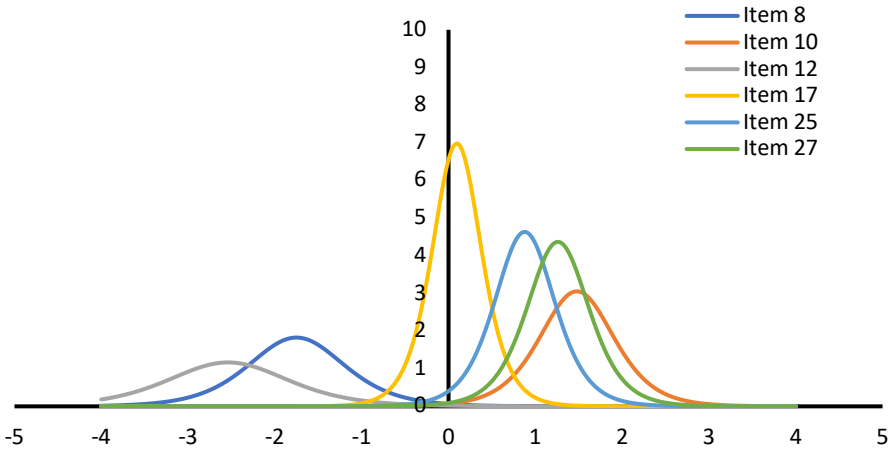

Figure 6.8. Composite 1 scale.

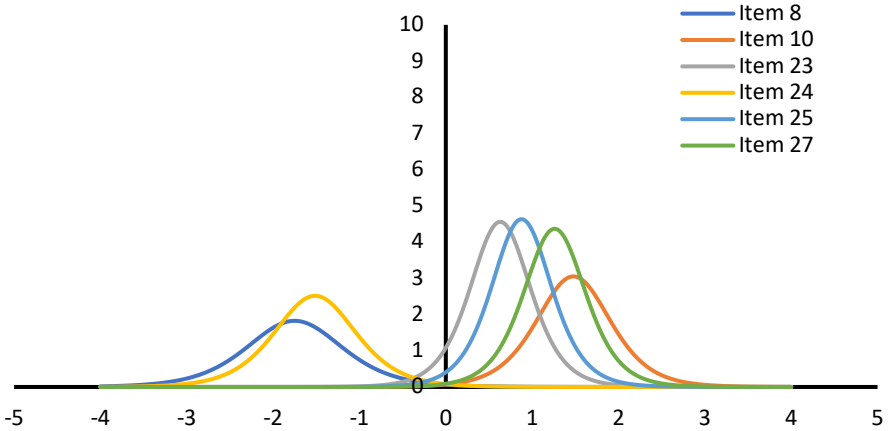

Figure 6.9. Composite 2 scale.

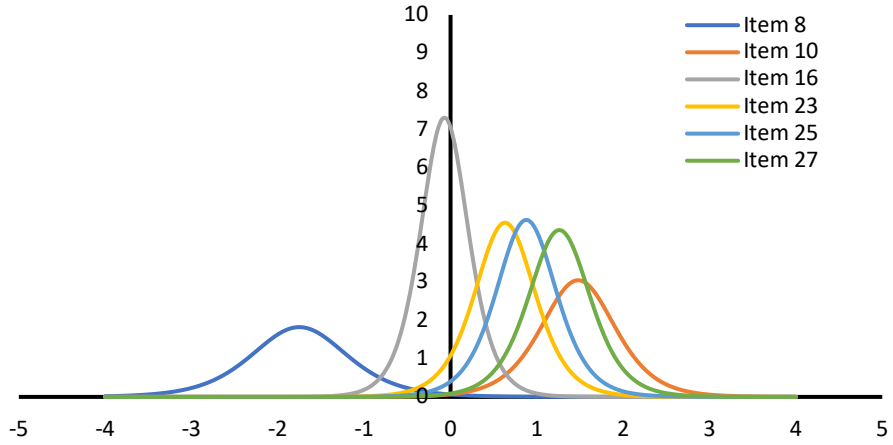

Figure 6.10. Composite 3 scale.

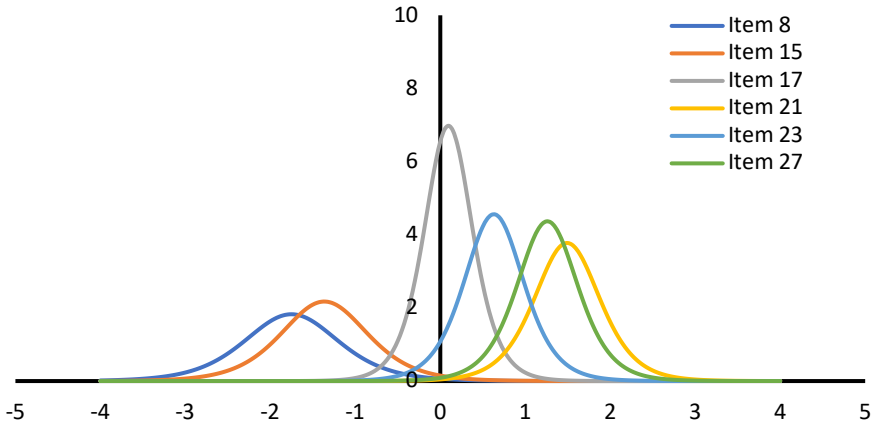

Figure 6.11. Composite 4 scale.

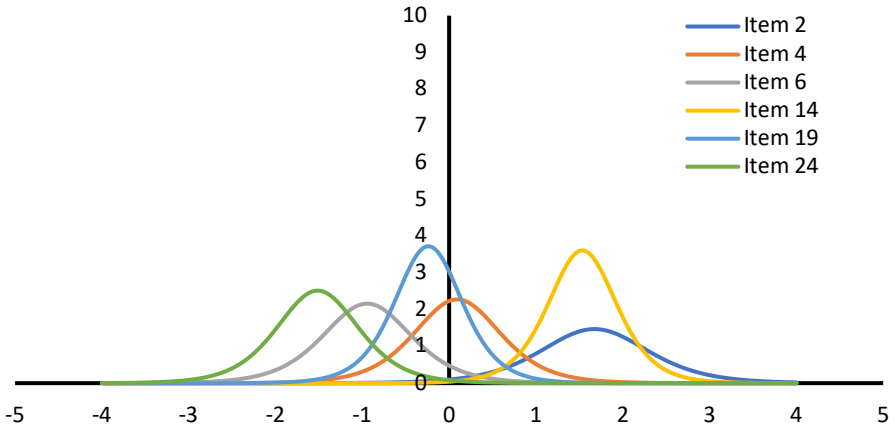

Figure 6.12. Composite 5 scale.

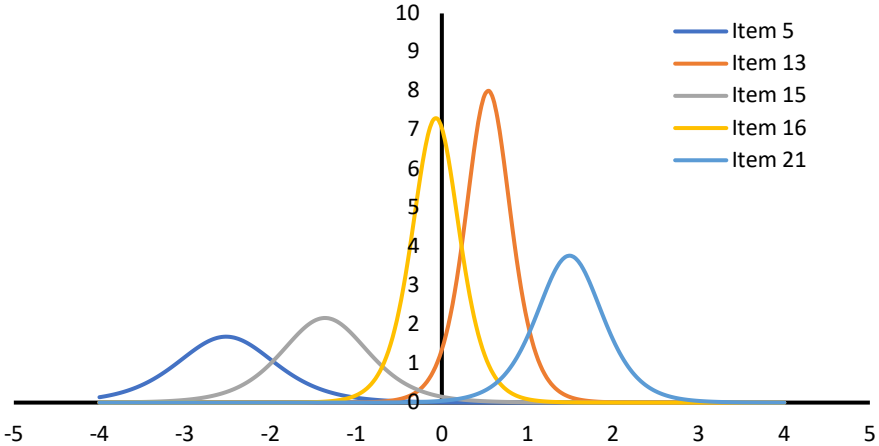

Figure 6.13. Composite 6 scale.

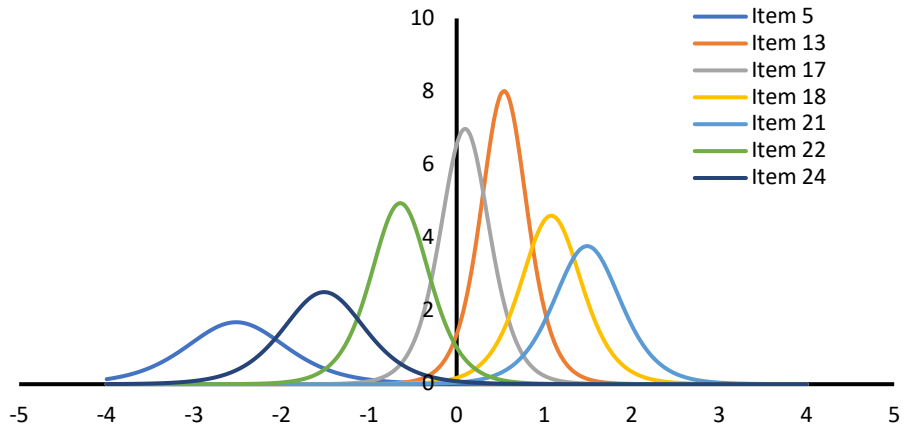

Figure 6.14. Composite 7 scale.

Table 5.

Item Retention for Each of the MCQ Scales

Order	Question	Group	*k*	a	b	c	d	e	f	g	h	i	j	k	l	m	n
13	Would you prefer $34 today, or $35 in 186 days?	Q1_1	0.00016	✓	✓	✓					✓					✓	✓
20	Would you prefer $28 today, or $30 in 179 days?	Q1_2	0.0004	✓	✓												
26	Would you prefer $22 today, or $25 in 136 days?	Q1_3	0.001	✓	✓	✓											
22	Would you prefer $25 today, or $30 in 80 days?	Q1_4	0.0025	✓	✓	✓					✓						✓
3	Would you prefer $19 today, or $25 in 53 days?	Q1_5	0.006	✓	✓												
18	Would you prefer $24 today, or $35 in 29 days?	Q1_6	0.016	✓	✓						✓						✓
5	Would you prefer $14 today, or $25 in 19 days?	Q1_7	0.041	✓	✓	✓					✓					✓	✓
7	Would you prefer $15 today, or $35 in 13 days?	Q1_8	0.1	✓	✓												
11	Would you prefer $11 today, or $30 in 7 days?	Q1_9	0.25	✓	✓	✓											
1	Would you prefer $54 today, or $55 in 117 days?	Q2_1	0.00016	✓			✓										
6	Would you prefer $47 today, or $50 in 160 days?	Q2_2	0.0004	✓			✓	✓							✓		
24	Would you prefer $54 today, or $60 in 111 days?	Q2_3	0.001	✓			✓	✓			✓				✓		✓
16	Would you prefer $49 today, or $60 in 89 days?	Q2_4	0.0025	✓			✓	✓					✓			✓	
10	Would you prefer $40 today, or $55 in 62 days?	Q2_5	0.006	✓			✓					✓	✓				
21	Would you prefer $34 today, or $50 in 30 days?	Q2_6	0.016	✓			✓				✓			✓		✓	✓
14	Would you prefer $27 today, or $50 in 21 days?	Q2_7	0.041	✓			✓								✓		
8	Would you prefer $25 today, or $60 in 14 days?	Q2_8	0.1	✓			✓	✓				✓	✓	✓			
27	Would you prefer $20 today, or $55 in 7 days?	Q2_9	0.25	✓			✓	✓				✓	✓	✓			
9	Would you prefer $78 today, or $80 in 162 days?	Q3_1	0.00016	✓					✓	✓							
17	Would you prefer $80 today, or $85 in 157 days?	Q3_2	0.0004	✓					✓		✓			✓			✓
12	Would you prefer $67 today, or $75 in 119 days?	Q3_3	0.001	✓					✓								
15	Would you prefer $69 today, or $85 in 91 days?	Q3_4	0.0025	✓					✓	✓				✓		✓	
2	Would you prefer $55 today, or $75 in 61 days?	Q3_5	0.006	✓					✓						✓		
25	Would you prefer $54 today, or $80 in 30 days?	Q3_6	0.016	✓					✓	✓		✓	✓				
23	Would you prefer $41 today, or $75 in 20 days?	Q3_7	0.041	✓					✓	✓		✓	✓	✓			
19	Would you prefer $33 today, or $80 in 14 days?	Q3_8	0.1	✓					✓	✓					✓		
4	Would you prefer $31 today, or $85 in 7 days?	Q3_9	0.25	✓					✓	✓					✓		

Note. a = Full MCQ; b = Small category; c = Small brief; d = Medium category; e = Medium brief; f = Large category; g = Large brief; h = Composite 1; i = Composite 2; j = Composite 3; k = Composite 4; l = Composite 5, m = Composite 6, n = Composite 7.

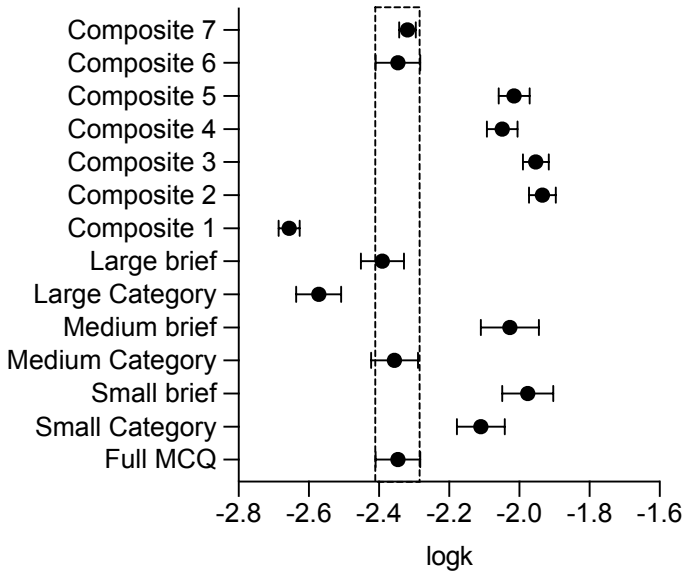

Figure 7.1. Pilot sample (n = 541)

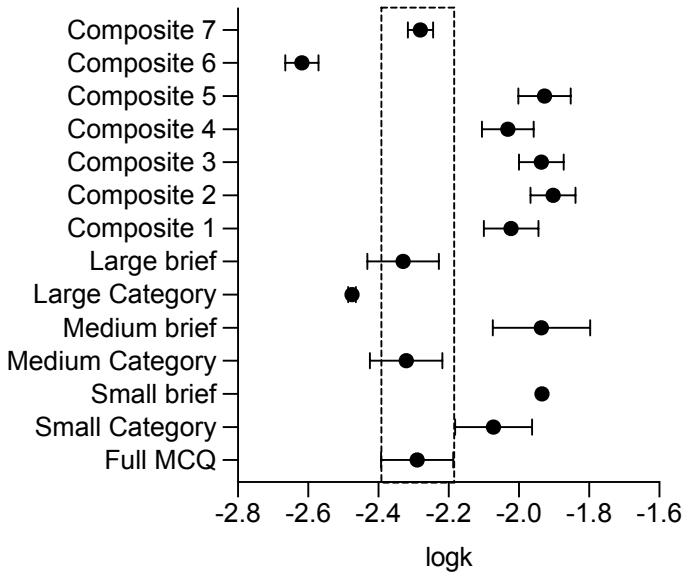

Figure 7.2. Validation sample (n = 170)

Figure 7.1—7.2. Mean and 95% confidence intervals of logk values for the full MCQ and test scales.

Table 6.

Correlations Between the Full MCQ and Test Scales

	Full MCQ			
	Pilot (n=541)		Validation (n=170)	
Medium category	.97	***	.97	***
Large brief	.93	***	.92	***
Composite 7	.85	***	.85	***

Note. *** Correlation significant less than .001

Table 7.

Descriptive Statistics for the High and Low AUDIT Groups

		Pilot			Validation		
Model	AUDIT	N	Mean	SD	N	Mean	SD
Full MCQ	<16	318	-2.34	0.76	152	-2.05	0.54
	≥16	42	-2.11	0.70	17	-2.31	0.69
Medium baseline	<16	318	-2.36	0.81	152	-2.28	0.68
	≥16	42	-2.06	0.75	17	-2.47	0.78
Large brief	<16	318	-2.39	0.75	152	-2.12	0.51
	≥16	42	-2.17	0.62	17	-2.35	0.69
Composite 7	<16	318	-2.65	0.36	152	-2.63	0.32
	≥16	42	-2.59	0.30	17	-2.51	0.21

Table 8.

Independent Samples T-test for Difference of the logk Values Between High and Low AUDIT Groups

	Pilot				Validation			
Model	t	df	p	d	t	df	p	d
Full MCQ	1.87	358	.063	.31	-1.53	168	.123	.39
Medium baseline	2.32	358	**.021**	**.38**	-1.87	168	.061	.48
Large brief	1.80	358	.073	.30	-1.35	168	.172	.35
Composite 7	1.18	358	.239	.19	-1.57	168	.118	.40

Study 1: Interim Discussion

Scale reduction resulted in 10 brief scales, each comprising 5–7 items based on items from the 27-item full questionnaire (three brief versions of the small, medium and large value category scales and seven composite scales that used questions from two or more value categories). The three existing reward categories (small, medium and large, each comprising nine items) were included in the analyses to assess if they were valid short forms of the full MCQ. Three of the 13 identified scales (i.e., the medium category scale with 9-items, the large brief scale with six-items and the composite seven scale with 9-items) replicated the full MCQ in both the pilot and validation datasets. The medium category, large brief and composite seven scales were significantly, positively and strongly correlated with the full MCQ. In the pilot dataset, the medium category scale revealed that those in the high AUDIT group displayed significantly greater discounting than those in the low AUDIT group. The medium category scale did not replicate the significant finding in the validation dataset but did achieve a medium effect size (d = .48). The full MCQ, the large brief and composite 7 scales were not sufficiently sensitive to differentiate between the groups in terms of discounting.

Study 2 Method: Analysis of Reliability and Validity

Participants

Sixty-eight participants, aged 20–64 years old, were recruited through social media and poster advertisements that were posted around the University of Tasmania. Participants were excluded if they self-reported that they had uncorrected eyesight problems, concerns regarding attention and memory, current mental health problems, major physical health complaints, were currently taking a psychoactive medication or spoke a primary language other than English. Ethics approval was obtained from Human Ethics Research Committee (H0018073; Appendix E).

Materials

A demographic survey was used to collect information about the participants' age, education, smoking status, possible health conditions and any medication that they had consumed in the 24 hours preceding the session.

The *Wechsler Test of Adult Reading* (WTAR) was used to ensure participants' comprehension of task instructions and provide an index of general cognitive function (r = 0.75 with Wechsler Adult Intelligence Scale [WAIS] Verbal Intelligence Quotient [IQ]; Wechsler, 2001). The test requires individuals to pronounce 50 words that have irregular graphemes and phonemes. Scores are based on the total number of words that an individual has pronounced correctly.

The *N-Back task* was used as an index of working memory function (Kirchner, 1958). Participants were shown a sequence of letters presented at a rate of 15 stimuli per 20 seconds. Participants were instructed to respond if the letter displayed matched a letter shown *n* places earlier. Participants completed the task with a 1-, 2- and 3-back condition that was presented sequentially in blocks. The test included 12 targets in the 1-back condition and 24 targets in the 2- and 3-back condition. The stimuli were presented for one second. Targets were

randomly presented at a probability of 10%. The percentage of correct responses and associated reaction times were measured.

The *Stop Signal Task* was used as an index of response inhibition (Logan & Cowan, 1984). The task is a forced dichotomous choice paradigm that requires individuals to make a left button response when a 'X' appears or a right button response when an 'O' appears. A central fixation point was presented for 500 ms at the start of the task for eye fixation and attention. A stop signal (two horizonal red lines) was presented over the stimuli after a delay in 25% of the 48 trials. The initial stop signal appeared 250 ms after the stimuli onset. The presentation onset increased by 50 ms following failure to inhibit and decreased by 50 ms following a successful inhibition. The reaction time (measured in milliseconds) was estimated by subtracting the stop signal delay from the average go signal response time. The percentage of correctly stopped trials was also measured.

Procedure

Participants were invited to complete a screening survey online and were contacted once deemed eligible to participate. The study comprised two sessions, which were held approximately one week apart at the same time of day. Participants provided demographic information and completed the WTAR in the first session and the MCQ, N-back and Stop Signal Task in both sessions. The two sessions were run in the same sequence to reduce variability from differential fatigue effects. Additional tasks from parallel projects were included in each test battery.

Data Analysis

Descriptive statistics for each sex and age block were calculated. Test-retest stability was assessed using Pearson correlations for each scale at the baseline and retest timepoints. Paired sample t-tests with effect sizes and parallel Bayes Factors were calculated to determine if there was evidence for a change in scores over time. The

concurrent validity of the MCQ scales was assessed by Pearson correlations between MCQ scales and measures of working memory and response inhibition. Analyses were conducted in Jamovi 1.1.5 and Stata 16.0.

Study 2 Results

Sixty-eight participants (35 female and 23 male) aged 20–64 years (M = 41.1, SD = 13.7) completed the test battery twice, approximately one week apart. Descriptive statistics of discounting rates (logk values) for each age group are presented in Table 9 and in plots Figures 8.1–8.4. Descriptive statistics for the Stop Signal Task and N-Back task are provided in Table 10.

The results of the test-retest analyses (correlation, t-tests and Bayesian t-tests) are provided in Table 11. A visual inspection of the plots of individual rates of discounting between baseline and retest sessions (see Figures x.1–x.4), indicated relatively similar changes between the Full MCQ, medium category and large brief scale. It was evident from the composite seven plot that the discounting scores logk > –2.13 were not possible, thus indicating a ceiling effect. Correlation analysis revealed that the full MCQ, medium category, large brief and composite seven scales demonstrated strong significant relationships between baseline and retest timepoints (all $r \geq .69$). Matched pairs t-tests between timepoints were nonsignificant for the medium category, large brief and composite seven scales (all $p \geq .121$). There was a significant difference in discounting between test and retest for the full MCQ, such that discounting at the baseline was significantly greater than discounting at the retest ($d = .28$). Bayesian t-tests demonstrated that the large brief and composite seven scales had good evidence in favour of no change between test and retest (as evidenced by Bayes factors of > 3). The full MCQ and medium category scales did not have good evidence in favour of no change; however, the medium category scale was nearing the cut off ($BF_{01} = 2.29$). Considering the three test-retest

analyses together, the composite seven, medium category and large brief scales achieved good temporal stability. The full MCQ did not indicate good test-retest reliability due to a statistically significant, small magnitude effect of changes in discounting between sessions, and a Bayes Factor < 3.

In relation to concurrent validity, there were weak magnitude relationships between all the MCQ scales and measures of working memory (N-back: $r \leq .15$) and inhibitory control (Stop Signal: $r \leq .22$).

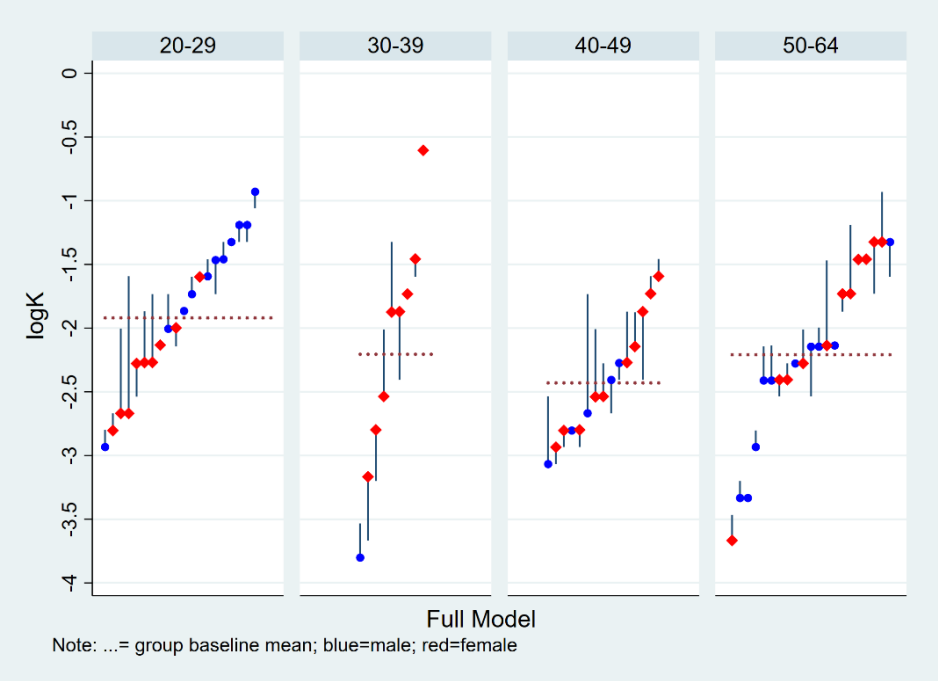

Figure 8.1. Full MCQ.

Figures 8.1—8.4. Delay discounting rates for each participant between baseline and retest sessions.

Note. The red and blue symbols represent the female and male participants, respectively. A change in score is represented by an upwards or downwards line. The full MCQ, medium category and large brief scales show similar group means within each age group and similar changes between timepoints. The plot of the composite seven scale indicates that it was not possible to achieve a discounting score greater than logk = –2.13

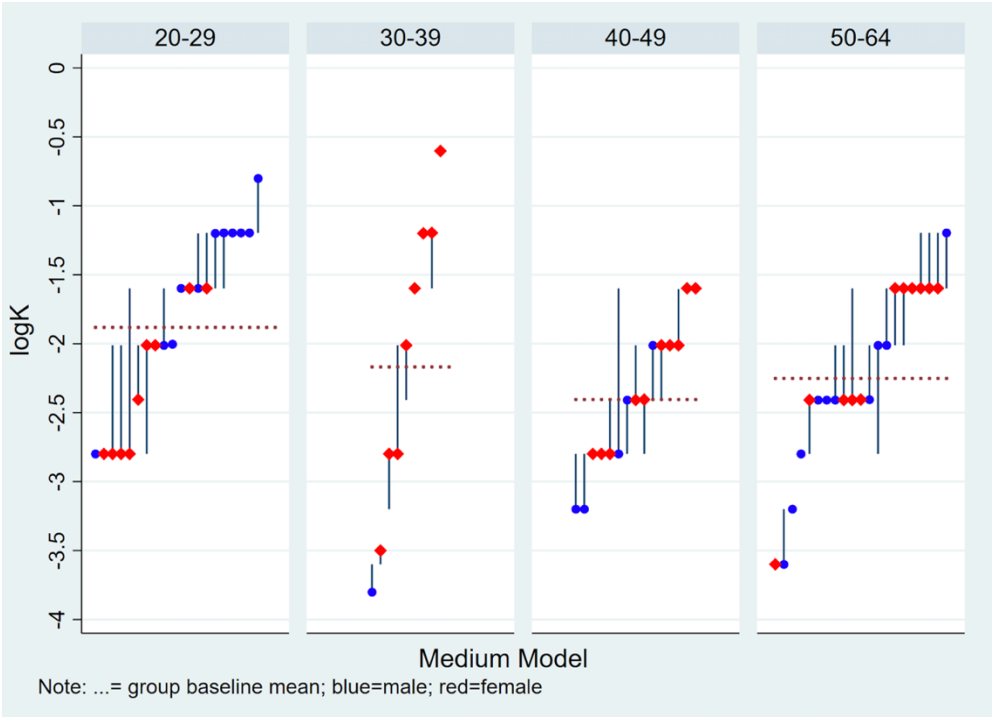

Figure 8.2. Medium category scale.

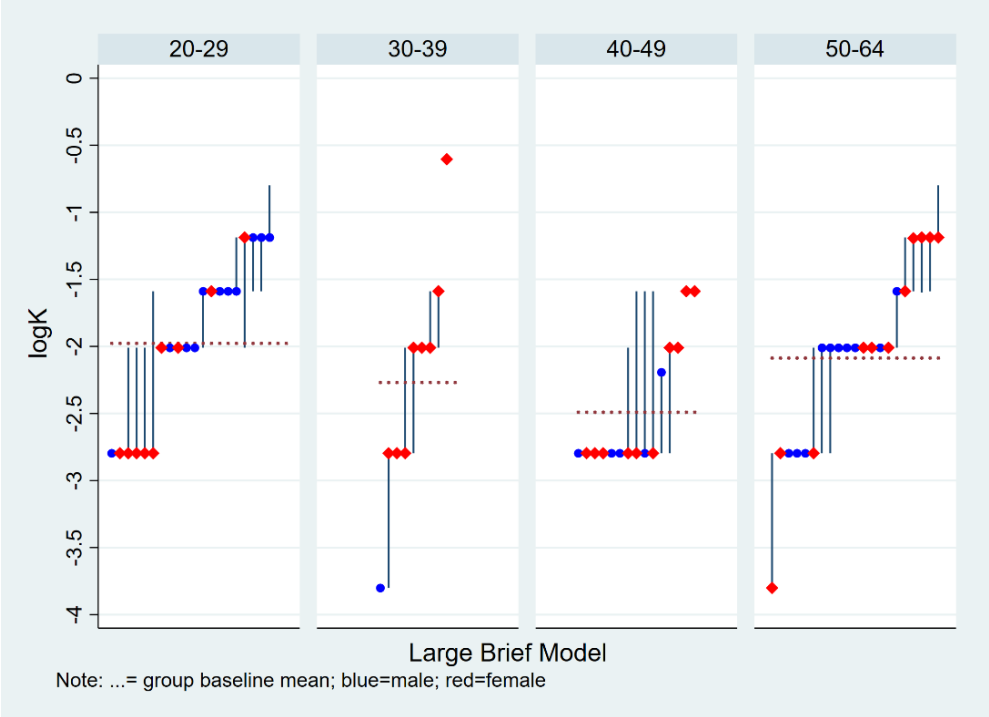

Figure 8.3. Large brief scale.

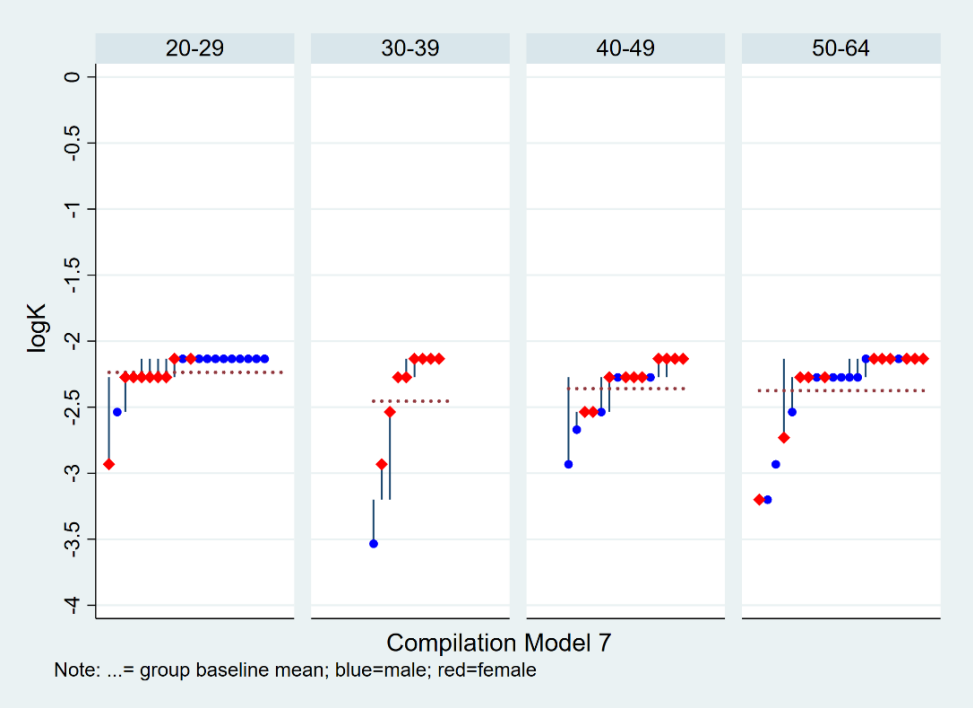

Figure 8.4. Composite 7 scale.

Table 9.

Descriptive Statistics of Delay Discounting Rates (logk) For Each of the MCQ Scales Between Test and Retest Timepoints.

			Full MCQ		Medium Category		Large Brief		Composite 7	
			1	2	1	2	1	2	1	2
N	Male	20-29	11	11	11	11	11	11	11	11
		30-39	1	2	1	2	1	2	1	2
		40-49	5	5	5	5	5	5	5	5
		50-59	8	8	8	8	8	8	8	8
		60-64	2	2	2	2	2	2	2	2
	Female	20-29	9	10	9	10	9	10	9	10
		30-39	8	8	8	8	8	8	8	8
		40-49	10	10	10	10	10	10	10	10
		50-59	9	9	9	9	9	9	9	9
		60-64	2	2	2	2	2	2	2	2
M	Male	20-29	-1.61	-1.60	-1.53	-1.56	-1.81	-1.74	-2.17	-2.17
		30-39	-3.80	-2.97	-3.80	-3.20	-3.80	-3.10	-3.53	-2.74
		40-49	-2.64	-2.43	-2.72	-2.48	-2.88	-2.55	-2.54	-2.33
		50-59	-2.49	-2.48	-2.45	-2.50	-2.65	-2.80	-2.49	-2.42
		60-64	-2.27	-2.14	-2.41	-2.01	-2.41	-2.41	-2.20	-2.27
	Female	20-29	-2.30	-2.06	-2.31	-2.04	-2.40	-2.28	-2.32	-2.22
		30-39	-2.01	-2.07	-1.96	-2.03	-2.23	-2.35	-2.32	-2.44
		40-49	-2.32	-2.24	-2.24	-2.20	-2.56	-2.36	-2.27	-2.32
		50-59	-2.02	-1.88	-2.09	-2.00	-2.02	-2.00	-2.35	-2.28
		60-64	-1.87	-1.73	-2.00	-1.80	-1.80	-1.80	-2.20	-2.20
SD	Male	20-29	0.54	0.47	0.56	0.49	0.61	0.52	0.12	0.12
		30-39	N/A	0.80	N/A	0.57	N/A	0.98	N/A	0.66
		40-49	0.32	0.42	0.52	0.52	0.18	0.54	0.28	0.12
		50-59	0.68	0.60	0.75	0.63	0.64	0.52	0.38	0.41
		60-64	0.19	0.00	0.00	0.00	0.00	0.00	0.10	0.00
	Female	20-29	0.39	0.37	0.52	0.52	0.60	0.38	0.24	0.13
		30-39	0.81	0.99	0.99	1.01	0.82	1.05	0.28	0.48
		40-49	0.48	0.58	0.47	0.51	0.54	0.70	0.16	0.16
		50-59	0.75	0.78	0.69	0.83	0.90	0.85	0.37	0.35
		60-64	0.58	0.39	0.57	0.29	0.86	0.30	0.10	0.10

Table 10.

Descriptive Statistics for The Stop Signal Task and N-back

			SST RT		SST NT		N-back RT		N-back PC	
			1	2	1	2	1	2	1	2
N	Male	20-29	11	11	11	11	11	11	11	11
		30-39	2	2	2	2	2	2	2	2
		40-49	5	5	5	5	5	5	5	5
		50-59	8	8	8	8	8	8	8	8
		60-64	2	2	2	2	2	2	2	2
	Female	20-29	11	11	11	11	11	11	11	11
		30-39	8	8	8	8	8	8	8	8
		40-49	10	10	10	10	10	10	10	10
		50-59	9	9	9	9	9	9	9	9
		60-64	2	2	2	2	2	2	2	2
M	Male	20-29	383	419	0.59	0.61	597	577	0.72	0.74
		30-39	402	602	0.60	0.67	660	695	0.70	0.71
		40-49	478	499	0.67	0.67	605	593	0.76	0.79
		50-59	483	559	0.67	0.70	681	658	0.63	0.68
		60-64	589	558	0.69	0.75	690	678	0.51	0.58
	Female	20-29	432	449	0.64	0.65	627	608	0.70	0.71
		30-39	493	551	0.67	0.69	665	612	0.68	0.75
		40-49	391	438	0.61	0.64	675	628	0.66	0.73
		50-59	547	524	0.72	0.71	626	633	0.66	0.69
		60-64	483	477	0.63	0.69	661	628	0.70	0.84
SD	Male	20-29	172	191	0.10	0.11	77.3	67.1	0.11	0.09
		30-39	62	97	0.03	0.12	16.0	99.7	0.00	0.03
		40-49	162	194	0.08	0.11	60.3	52.2	0.12	0.08
		50-59	102	153	0.10	0.10	47.0	49.2	0.09	0.13
		60-64	144	47	0.09	0.00	46.8	69.5	0.14	0.05
	Female	20-29	151	175	0.12	0.14	53.7	63.4	0.10	0.18
		30-39	147	169	0.10	0.10	112.0	83.4	0.09	0.12
		40-49	127	213	0.11	0.12	63.5	94.2	0.16	0.10
		50-59	88	124	0.07	0.10	100.0	85.4	0.19	0.08
		60-64	30	86	0.00	0.15	36.8	55.2	0.06	0.07

Note. RT = reaction time, NT = number correct, PC = percentage correct.

Table 11.

Correlations Between MCQ Scales and The Stop Signal and N-back Tasks

			Full MCQ		Medium Category		Large Brief		Composite 7	
			1	2	1	2	1	2	1	2
SST RT	1	r	-.03	-.03	-.09	-.03	-.03	-.07	-.12	-.06
		p	.80	.81	.49	.79	.81	.58	.36	.66
	2	r	-.18	-.17	-.18	-.15	-.16	-.19	-.22	-.20
		p	.14	.17	.15	.22	.21	.12	.08	.11
SST NR	1	r	.00	.04	-.04	.02	-.03	-.01	-.04	.01
		p	.99	.76	.77	.87	.84	.97	.74	.94
	2	r	-.13	-.14	-.14	-.11	-.13	-.18	-.19	-.17
		p	.30	.27	.28	.37	.32	.15	.13	.18
Nback RT	1	r	-.05	-.03	.01	-.08	-.03	.01	-.05	-.08
		p	.71	.80	.96	.83	.83	.93	.70	.55
	2	r	-.15	-.09	-.11	-.11	-.10	-.06	-.18	-.11
		p	.25	.48	.41	.38	.44	.61	.32	.37
Nback PC	1	r	-.06	-.04	-.05	-.06	-.12	-.06	.04	.04
		p	.65	.78	.69	.62	.33	.64	.78	.73
	2	r	-.02	-.15	-.07	-.14	-.04	-.23	-.03	-.15
		p	.87	.23	.56	.26	.75	.06	.80	.21

Note. SST = Stop Signal Task, RT = reaction time, NR = number right inhibitions, PC = percentage correct.

Table 12.

Correlation, T-test and Bayesian T-test Between Baseline and Re-test Timepoints

Model	Correlation		t-test			Bayesian t-test
	r	p	t	p	d	BF_{01}
Full MCQ	**.88**	**<.001**	**-2.22**	**.030**	**.28**	**0.75**
Medium category	**.83**	**<.001**	-1.57	.121	.20	2.29
Large brief	**.69**	**<.001**	-0.89	.376	.11	5.03
Composite 7	**.80**	**<.001**	-1.12	.265	.14	4.03

Note. Bayes factor > 3 indicates good evidence in favour of no change.

Study 2: Interim Discussion

The hypothesis that the MCQ scales would have good test-retest reliability was partially supported. Specifically, the medium category, large brief and composite seven scales, but not the full MCQ, achieved good test-retest reliability. The full MCQ had strong significant correlations between test and retest but had significantly different discounting between timepoints and did not have good evidence in favour of no change through the Bayesian t-test. The hypothesis that the MCQ scales would significantly correlate with the Stop Signal or N-back task was not supported.

Study 3 Method: Delay Discounting During Acute Alcohol Intoxication

Participants

Thirty-seven participants were recruited from the general community through social media and poster advertisements that were posted at the University of Tasmania. To be eligible to participate in the study, participants had to meet the following selection criteria: have drunk a minimum of two alcoholic beverages in the preceding month, have normal or corrected-to-normal vision, speak English as their first language, have completed high school or an equivalent, have a body mass index (BMI) between 18.5 and 29.9, show an absence of significant clinical distress (as measured by a score of less than 25 on the Kessler Psychological Distress Scale: K10; Kessler et al., 2002), have average premorbid intellectual functioning (as measured by a normed IQ score of > 85 on the WTAR) and have normal sleep patterns. Participants were excluded if they self-reported regular tobacco use, illicit drug use in the preceding six months, hazardous alcohol use (as measured by an AUDIT score of greater than 16), current psychoactive medication or any recent history of a physical or mental condition. Ethics approval was obtained from the Human Research Ethics Committee (H0016125; Appendix G).

Materials

The tasks and questionnaires included the WTAR, the MCQ, the N-Back and the Stop Signal Task (see above). Breath Alcohol Concentration (BrAC) was measured at 10-minute intervals following the initiation of drinking, using Andatech AlcoSense Prodigy S police-grade breathalysers. The device is an Australian standards (AS3547) certified breathalyser that is used in law enforcement contexts.

Procedure

Eligible participants were invited to a 4-hour laboratory session. They were asked to abstain from consuming alcohol for 24 hours before the session, to drink no coffee on the day of testing and to refrain from eating for four hours before the session. Upon arrival, participants provided informed consent, underwent a preliminary BrAC assessment and completed the WTAR. Tasks were performed on an android 10" tablet using Penscreen software and were explained verbally and via instruction sheets before administration. Participants completed the MCQ, three levels of N-Back (1-back, 2-back, 3-back) and the Stop Signal Task at the baseline, at 0.08% BrAC and at 0.05% BrAC on the descending limb.

An opaque bottle containing an alcoholic beverage of 37.5% alcohol/volume vodka (dose based on Widmark equation; Watson, Watson, & Batt, 1981), 300 mls of soda water and 100 mls of flavoured sugar cordial syrup was administered to participants and consumed at a steady pace over a 10-minute period. After finishing the beverage, participants rinsed their mouths with water to ensure that any mouth alcohol did not bias the BrAC recording. Following the completion of the final assessment battery, the participants were offered food and were required to stay in the laboratory until their BrAC declined to 0.03%.

Data Analysis

Mixed models for repeated measures were conducted with participants treated as a random factor. The analyses aimed to investigate if there was an effect of alcohol intoxication

on delay discounting, as measured by *k* values from the MCQ models, after controlling for covariates. Timepoint was treated as a fixed factor (at the baseline, 0.08% BrAC, 0.05% BrAC descending). Possible covariates included AUDIT score, age, sex (as a fixed factor), and BMI. The analyses were conducted in IBM SPSS 26.

Study 3: Results

Thirty-seven participants (22 female and 15 male), aged 18 to 31 years, completed the test battery at the following timepoints: baseline, peak BrAC 0.08% and BrAC 0.05% on the descending limb (for the additional demographics, see Table 13). The results of participants' performance on each task are provided in Figures 9.1—9.4.

Table 13.

Participant Characteristics.

Variable	M (SD)	Range
Age (years)	22.84 (3.12)	18 - 31
Harmful alcohol use (AUDIT)	6.57 (2.81)	1 - 14
Psychological distress (K10)	15.03 (3.97)	10 - 28
Body mass index (kg/m^2)	23.88 (3.14)	18.5 – 31.2

BMI and sex were included as covariates or included as factors in the models, respectively, as they demonstrated significant associations with the outcomes. Other variables (i.e., age and AUDIT score) were not significantly related to the outcomes. There were no significant effects of timepoint (i.e., at the BrAC levels) on any of the MCQ scales (see Table 14; non-covariate-adjusted analyses provided in Appendix I). Similarly, there were no significant effects of sex. There were no statistically significant sex*timepoint interactions; however, there were small magnitude sex differences in discounting, such that males demonstrated greater discounting at 0.08% than women (full MCQ: d = .33; medium category: d = .35; large brief: d = .39; composite 7: d = .23).

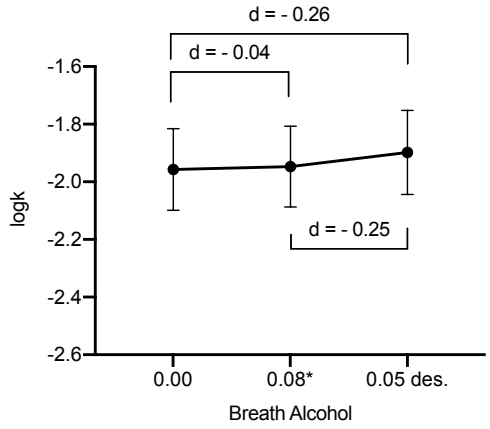

Figure 9.1. Full MCQ.

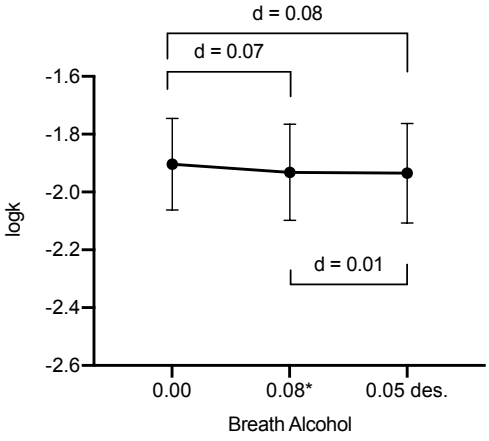

Figure 9.2. Medium category.

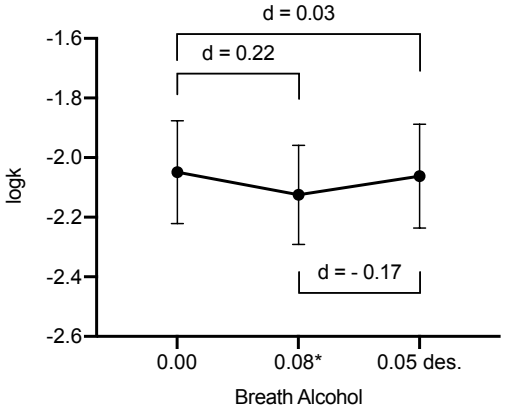

Figure 9.3. Large brief.

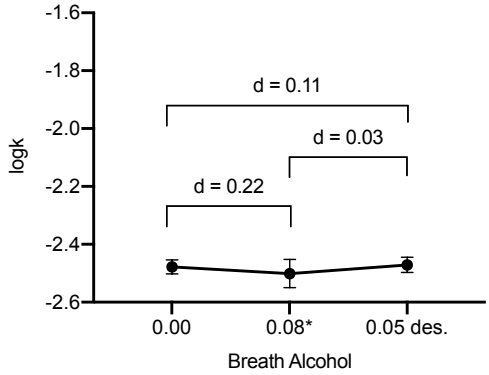

Figure 9.4. Composite seven.

Figures 9.1—9.4. Delay discounting rates for each MCQ scale at the baseline and 0.08% BrAC and 0.05% BrAC on the descending limb following an acute alcohol dose.

Table 14.

Timepoint and Sex Effects and Interactions Controlling for BMI.

	Timepoint * Sex				Timepoint				Sex			
Model	F	df_1	df_2	*p*	F	df_1	df_2	*p*	F	df_1	df_2	*p*
Full MCQ	0.18	2	37.8	.152	1.54	2	51.4	.227	3.79	1	34.1	.060
Medium Category	1.19	2	38.2	.314	0.15	2	38.2	.859	3.67	1	34.1	.064
Large brief	0.91	2	39.6	.412	1.06	2	39.6	.357	4.05	1	32.6	.052
Composite 7	0.12	2	43.3	.884	0.83	2	43.3	.442	4.07	1	52.7	.049

Study 3: Interim Discussion

The hypothesis that acute alcohol intoxication would result in greater delayed discounting was not supported in relation to any of the examined scales.

General Discussion

The primary aim of the present investigation was to develop a brief, valid, reliable and sensitive version of the MCQ. The secondary aim was to assess if the MCQ was sensitive to acute alcohol intoxication. Of the 13 brief scales developed, three of the brief scales (i.e., the nine medium category items from the original MCQ and the two 6–7-item scales, one of which took items solely from the large MCQ category items [‘the large brief scale’] and one which took items from both the medium and large MCQ categories [‘the composite 7 scale’]) were able to capture discounting rates that were comparable to those produced by the 27 items of the full original MCQ.

Of the four tested scales (including the full MCQ), only the medium category scale was able to differentiate between the AUDIT groups. The medium category scale was sensitive to differences in discounting rates between the high and low AUDIT groups. Consequently, this scale was able to show that the high group displayed significantly steeper discounting than the low AUDIT group. These findings support those of previous studies that showed that heavy drinkers are steeper discounters than light drinkers (Adams et al., 2017) and that individuals experiencing SUD display higher discounting rates than those without SUD (MacKillop et al., 2011). Conversely, the full MCQ, large brief scale and composite 7 scales were not able to differentiate between the high and low AUDIT groups.

The finding that the 9-item medium category scale was more predictive of hazardous alcohol use than the full 27-item questionnaire was particularly interesting. Due to the large number of items, the greater resolution of the full MCQ resulted in unnecessary noise. The small category scale did not replicate the full MCQ, as it produced discounting rates that

were substantially greater than those produced by the full questionnaire. Similarly, the large category scale did not replicate the full MCQ, as the overall discounting rates were substantially smaller than those of the full questionnaire. This suggests that a large number of the items in the small and large scales did not adequately reflect true discounting scores, which subsequently led to a greater variance in scores and is also likely to have limited the sensitivity of the scales to differences between the high and low AUDIT groups. Similar to the full MCQ, the items in the large brief scale and composite 7 scales did not contain the information and the degree of discounting necessary to be sensitive to differences between the high and low AUDIT groups. Conversely, the items in the medium category scale were a more precise reflection of the overall discounting rates of the full MCQ. This precision resulted in less variance in the scores and increased the sensitivity of the scale in distinguishing between the high and low AUDIT groups.

In addition to the large brief scale and composite 7 scales, the medium category scale also demonstrated more stable test-retest reliability than the full MCQ. With the exception of the composite 7 scale, which displayed a ceiling effect, a visual inspection of the individual discounting rates and the amount of change between the baseline and retest scores revealed comparable stability between each scale. The composite 7 scale underestimated the discounting rates, as it was not possible to achieve a score above a logk of –2.13. Each of the four scales achieved large significant correlations between baseline and retest. There was a statistically significant small magnitude change of discounting between the timepoints in the full MCQ. Further, the Bayesian t-tests did not indicate strong evidence in favour of no change. Thus, despite a large correlation between timepoints, it appears that the full questionnaire was not stable across a one-week period. This is inconsistent with previous research findings that have reported good reliability as evidenced by strong significant correlations of three retest periods between 5 and 57 weeks (Kirby, 2009). The present

analysis was strengthened by two additional analyses of test-retest reliability: paired samples t-tests and Bayesian t-tests. In comparison to the full MCQ, the medium category, large brief scale and composite 7 scales, showed good test-retest reliability (as evidenced by strong correlations, non-significant t-tests and larger Bayes factors that indicated good evidence in favour of no change).

Table 15 sets out the overall findings for the scale reduction, validation and test-retest analyses. The medium category, large brief and composite 7 scales replicated the full questionnaire. The medium category scale differentiated between the high and low AUDIT groups. The subsequent scales, including the full MCQ, were not sensitive to differences between the two groups. The medium category, large brief scale and composite 7 scales, but not the full MCQ, had good test-retest reliability. Thus, the 9-item questionnaire, which only comprised medium-sized delayed rewards ($50–65), was the most robust of the tested scales. Further, despite using only a third of the items, it was also more powerful than the full questionnaire.

The findings of the current study have important implications for measuring delay discounting with the MCQ. First, the small and large category scales were not effective short forms of the full MCQ, as the discounting rates they captured were either greater or lower, respectively, than those of the full questionnaire. Second, as it contains items that are not an accurate reflection of the overall discounting rate, the full MCQ is not a robust predictor of risk behaviours. Additionally, it does not have good test-retest reliability. Conversely, the medium category scale is a robust and reliable alternative short form of the full questionnaire.

Table 15.

Overall Comparison of the Full MCQ and Brief Scales

Scale	Full MCQ	Medium	Large Brief	Composite 7
N items	27	9	6	7
Items	Small, medium and large items: 1-27	**Medium items:** 1 $54 today, or $55 in 117 days? 6 $47 today, or $50 in 160 days? 8 $25 today, or $60 in 14 days? 10 $40 today, or $55 in 62 days? 14 $27 today, or $50 in 21 days? 16 $49 today, or $60 in 89 days? 21 $34 today, or $50 in 30 days? 24 $54 today, or $60 in 111 days? 27 $20 today, or $55 in 7 days?	**Large items:** 4 $31 today, or $85 in 7 days? 9 $78 today, or $80 in 162 days? 15 $69 today, or $85 in 91 days? 19 $33 today, or $80 in 14 days? 23 $41 today, or $75 in 20 days? 25 $54 today, or $80 in 30 days?	**Small items:** 5 $14 today, or $25 in 19 days? 13 $34 today, or $35 in 186 days? 18 $24 today, or $35 in 29 days? 22 $25 today, or $30 in 80 days? **Medium item:** 21 $34 today, or $50 in 30 days? **Large item:** 17 $80 today, or $85 in 157 days?
Mean (logk)	n541: -2.35 n170: -2.30	n541: -2.36 n170: -2.32	n541: -2.39 n170: -2.48	n541: -2.32 n170: -2.28
Test-retest correlation (*r*)	.88	.83	.69	.80
Test-retest change (p, BF_{01})	.030, 0.75	.121, 2.29	.376, 5.03	.246, 4.03
ES for low and high AUDIT (d)	n541: .31 n170: .39	n541: .38 n170: .48	n541: .30 n170: .35	n541: .19 n170: .40
ES for alcohol intox (0.00 vs 0.08)	-.04	.07	.22	.22

Despite being a valid and reliable measure of discounting, the medium category scale was not sensitive to acute alcohol intoxication. The finding that discounting did not differ between baseline, peak 0.08% BrAC and 0.05% BrAC on the descending limb also applied to the full MCQ, large brief scale and composite 7 scales. The majority of previous studies in this area have shown similar results; that is, that acute alcohol intoxication has no effect on discounting (Adams et al., 2017; Bernhardt et al., 2019; Bidwell et al., 2013). This is with the exception of Reed et al. (2012), who observed an overall small magnitude dose effect of discounting between placebo, 0.5 g/kg and 0.75 g/kg alcohol conditions (d = .37). Reed et al. also used the MCQ as the chosen measure of discounting but did not transform the *k* values to either logarithms or natural logarithms. MCQ scores result in non-normal distribution due to positive skew and, as such, require logarithm transformed *k* values for analysis. Consequently, their observations were compromised, as they violated the assumptions of inferential statistics. Together, the findings suggest that while individuals suffering from alcohol dependence have higher levels discounting, acute alcohol intoxication does not lead to transient changes of delay discounting.

The overall finding that discounting is unaffected by acute alcohol intoxication is consistent with the notion that discounting is a trait rather than state-based form of impulsivity (Odum, 2011). Despite discounting being relatively stable overtime, the findings of some studies indicate that SUD treatment leads to reductions in delay discounting between pre- and post-treatment (Black & Rosen, 2011; Harvanko et al., 2019). The opposite has also been observed; that is, individuals experiencing opioid withdrawal have been found to display higher discounting rates relative to periods of satiation (Giordano et al., 2002). Thus, it appears that discounting is relatively stable over time and is not affected by acute alcohol intoxication, but can increase during periods of withdrawal and can decrease following treatment interventions.

The finding that there was no relationship between working memory and delay discounting (by the trivial non-significant effects for each MCQ scale: $r \leq .23$) is inconsistent with previous research that showed small to moderate negative correlations between discounting and working memory (Bickel et al., 2011; Shamosh et al., 2008). The aforementioned findings have been observed among both clinical and non-clinical populations and large (n = 103) and small samples (n = 27). A possible explanation of the disparate findings is that previous studies used working memory tasks with a high degree of difficulty (e.g., previous studies used only the 3-back component of the N-back or tasks that required individuals to memorise larger and more complex information). Conversely, the current investigation used a composite score based on performance on the 1-, 2- and 3-back trials. The use of an overall index of working memory, which included less challenging task components, may have limited the findings.

The current investigation observed trivial non-significant correlations between response inhibition and delay discounting. Generally, previous studies have found either no relationship between the two processes or weak statistically significant correlations (Dom et al., 2007; MacKillop et al., 2016). Delay discounting and response inhibition are argued to be different facets of impulsivity. Delay discounting is a measure of impulsive choice, while response inhibition is a measure of impulsive action. The findings of the present study support the notion that impulsive choice and impulsive action are independent aspects of impulsivity that have little or no overlap.

Overall, the current project comprised three studies and four datasets. Robust statistical methods were used to reduce the scale, analyse the validation and reliability of the scales and investigate the effects of acute alcohol intoxication on delay discounting. However, the current investigation is not without its limitations. First, none of the newly developed scales (each of which comprised 5–7-items) met all three criteria (of replication,

validity and reliability). There were 888,030 possible combinations of the 7-item scales based on the full 27-item questionnaire. Consequently, it may be that an as yet undiscovered combination could meet the aforementioned three criteria. A wide array of 5–7-item scales were developed and tested; however, only a few scales displayed adequate discounting rates that were comparable to those of the full MCQ. The inability of the newly developed scales to replicate the full MCQ suggests that the method used to score the questionnaire was sensitive to item reduction. The full MCQ is scored through the proportion (or geometric mean) of *k* values that correspond with each small immediate reward choice. Some items generally have a greater proportion of choices in which a small immediate reward is preferred to a larger delayed reward or vice versa. To develop a brief scale, a combination of items had to be found that provided sufficient 'information' about the discounting rate and had a relative balance between small or large reward choice. This task proved difficult. However, regardless of the aforementioned challenges, the medium category scale (comprising 9 items), the large brief scale (comprising 6 items) and the composite 7 scale (comprising 7 items) were able to capture similar discounting scores to those of the full questionnaire.

One limitation of the analysis of concurrent and convergent validity relates to the lack of an additional measure of delay discounting. The inclusion of another discounting task, such as the Adjusting Delay Discounting task (Richards et al., 1999), would have strengthened the validation of the medium category scale (as evidenced by the strong significant correlations between the two tasks). There is a large array of discounting tasks; however, the MCQ is the only measure that has adequate reliability and validity (Nguyen et al., 2018). Consequently, finding a comparable, psychometrically validated discounting task was not possible. Rather than including an additional measure of discounting, the Eyseneck I-5 Impulsivity Subscale (Eysenck & Eysenck, 1978) could have been included. This scale has been shown to significantly correlate with the MCQ (r = .27; Kirby et al., 1999). The full

MCQ has been used in a wide range of contexts and among both clinical and non-clinical populations. The medium category, large brief and composite 7 scales replicated the full scale and achieved strong significant correlations with the original task. Thus, these scales were shown to be comparable brief measures of delay discounting.

Another possible limitation of the current investigation was the lack of inclusion of a clinical sample. The use of a sample from the general community (rather than a sample from a clinical population) may have resulted in extremely high discounters being excluded. However, if this did occur, it does not appear to be a problem, as numerous participants in each sample achieved both the minimum and maximum discounting scores (i.e., a minimum *k*-value of 0.00016 that indicated shallow discounting and a maximum *k*-value of 0.25 that indicated steep discounting).

In relation to the medium category MCQ, it is important that future studies seek to replicate the current findings in a clinical population. This will enable an assessment to be made as to the presence of any ceiling effects. Ceiling effects may occur in populations of extremely high discounters, such as those experiencing cocaine or opiate dependences. Future research should also aim to establish ranges of discounting rates that correspond with specific treatment outcomes to match people with targeted, individualised treatment strategies.

As the medium category scale is efficient to administer, it is appropriate for use in clinical settings in which time and resources are limited. The development of a computerised version of the medium category MCQ (which is automatically scored and interpreted) would also increase the ease with which it could be used in such settings. Presently, scoring and interpreting the MCQ is time consuming and requires an understanding of hyperbolic discounting functions. A computerised version of the medium category MCQ (which provides automatic scoring, interpretation and treatment recommendations) would address the current barriers to the effective use of the MCQ in clinical settings. Measurements of

discounting before, during and after treatment could provide neurobehavioural insights into individuals' treatment progress and recovery. The medium category MCQ could also be used to identify people in need of additional support, which could consequently lead to improved treatment outcomes, such as long-term recovery and abstinence.

In summation, the current study aimed to develop a brief, valid and sensitive measure of delay discounting. The secondary aim of this study was to assess whether discounting was sensitive to acute alcohol intoxication. Notably, the results showed that discounting rates did not differ between the baseline, 0.08% and 0.05% BrAC. The medium category, large brief and composite 7 scales captured discounting rates comparable to those captured by the 27-item full questionnaire. The three brief scales also had good test-retest reliability; however, the composite 7 scale was limited by the presence of a ceiling effect. Of the four tested scales (including the full questionnaire), only the medium category scale was sufficiently sensitive to differences between high and low AUDIT groups. Thus, the medium MCQ is an efficient, reliable, valid and robust alternative to the full MCQ. It has great utility for use in clinical settings, as it could be used to efficiently identify individuals at risk of dropping out of treatment programs or relapsing.

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Appendix A

Ethics Amendment Approval Letter H0018064

UNIVERSITY of TASMANIA

05 June 2019

AssocProf Raimondo Bruno
C/- University of Tasmania

Sent via email

Dear AssocProf Bruno

REF NO: H0018064
TITLE: Development of a scale to measure adult alcohol intoxication risk behaviours

We are pleased to advise that acting on a mandate from the Tasmania Social Sciences HREC, the Chair of the committee considered and approved the above project on 29 May 2019.

Please ensure that all investigators involved with this project have cited the approved versions of the documents listed within this letter and use only these versions in conducting this research project.

This approval constitutes ethical clearance by the Tasmania Social Sciences HREC. The decision and authority to commence the associated research may be dependent on factors beyond the remit of the ethics review process. For example, your research may need ethics clearance from other organisations or review by your research governance coordinator or Head of Department. It is your responsibility to find out if the approvals of other bodies or authorities are required. It is recommended that the proposed research should not commence until you have satisfied these requirements.

In accordance with the National Statement on Ethical Conduct in Human Research, it is the responsibility of institutions and researchers to be aware of both general and specific legal requirements, wherever relevant. If researchers are uncertain they should seek legal advice to confirm that their proposed research is in compliant with the relevant laws. University of Tasmania researchers may seek legal advice from Legal Services at the University.

All committees operating under the Human Research Ethics Committee (Tasmania) Network are registered and required to comply with the *National Statement on the Ethical Conduct in Human Research* (NHMRC 2007 updated 2018).

Therefore, the Chief Investigator's responsibility is to ensure that:

(1) All investigators are aware of the terms of approval, and that the research is conducted in compliance with the HREC approved protocol or project description.

(2) Modifications to the protocol do not proceed until **approval** is obtained in writing from the HREC. This includes, but is not limited to, amendments that:

Human Research Ethics Committee (Tasmania) Network
Research Ethics and Integrity Unit
Office of Research Services
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Hobart Tasmania
7001
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UNIVERSITY of TASMANIA

(i) are proposed or undertaken in order to eliminate immediate risks to participants;
(ii) may increase the risks to participants;
(iii) significantly affect the conduct of the research; or
(iv) involve changes to investigator involvement with the project.

Please note that all requests for changes to approved documents must include a version number and date when submitted for review by the HREC.

(3) Reports are provided to the HREC on the progress of the research and any safety reports or monitoring requirements as indicated in NHMRC guidance. Researchers should notify the HREC immediately of any serious or unexpected adverse effects on participants.

(4) The HREC is informed as soon as possible of any new safety information, from other published or unpublished research, that may have an impact on the continued ethical acceptability of the research or that may indicate the need for modification of the project.

(5) All research participants must be provided with the current Participant Information Sheet and Consent Form, unless otherwise approved by the Committee.

(6) This study has approval for four years contingent upon annual review. A *Progress Report* is to be provided on the anniversary date of your approval. Your first report is due 29 May 2020, and you will be sent a courtesy reminder closer to this due date. Ethical approval for this project will lapse if a Progress Report is not submitted in the time frame provided

(7) A *Final Report* and a copy of the published material, either in full or abstract, must be provided at the end of the project.

(8) The HREC is advised of any complaints received or ethical issues that arise during the course of the project.

(9) The HREC is advised promptly of the emergence of circumstances where a court, law enforcement agency or regulator seeks to compel the release of findings or results. Researchers must develop a strategy for addressing this and seek advice from the HREC.

Should you have any queries please do not hesitate to contact me on (03) 6226 6254 or via email ss.ethics@utas.edu.au.

Yours sincerely

Jude Vienna-Hallam
Executive Officer I Social Sciences

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Appendix B

Information and Consent Form H0018064

NATIONAL DRUG AND
ALCOHOL RESEARCH CENTRE

UNIVERSITY of
TASMANIA

ONLINE PARTICIPANT INFORMATION STATEMENT
Development of a scale to measure adult alcohol intoxication risk behaviours
Dr Amy Peacock

(http://www.counsellingonline.org.au/en/); or SANE (1800 18 7263 or http://www.sane.org/) to assist you if necessary.

6. **What are the possible benefits to participation?**
We hope to use information we get from this research study to benefit others who consume alcohol, in that we can use the scale we develop to measure changes in risk-taking following education or treatment regarding the possible harms of alcohol use.

7. **What will happen to information about me?**

Submission of the online questionnaire is an indication of your consent. By clicking the 'I agree to participate' button you are providing your permission for the research team to collect and use information about you for the research study.

The survey will be administered via KeySurvey, a data collection program of WorldApps. Data collected via KeySurvey is stored in the WorldApps secured data centre in North America. Data can only be accessed by the survey account owner (Dr Amy Peacock). Full privacy details for WorldApps is available here: https://www.keysurvey.com/privacy-policy/#p7

Data will be downloaded from KeySurvey and stored in accordance with data management procedures of the National Drug and Alcohol Research Centre. Data files will be password-protected and stored on the secure NDARC server. Access to the files (and the specific directories where the files are stored) will require a UNSW staff ID and password. Only those researchers named in the ethics application will have access to these directories.

We will store information about you in a de-identified format (i.e., personal information such as email address stored separately from your data) on a secure server. Your information will only be used for constructing a measure of risk-taking following alcohol use, and no individual data will be published. We will compare unique identifiers from the original survey and follow-up survey to link the two; no other details will be used to link the data.

Following completion of the project, data will be stored under the same conditions as during analysis on the NDARC server; data on the WorldApps server can be deleted at any point by Dr Peacock, and all data will be deleted from this server at the conclusion of the study. All electronic files on the NDARC server will be deleted after seven years.

8. **How and when will I find out what the results of the research study are?**
The research team intend to publish and/ report the results of the research study in a variety of ways. All information published will be done in a way that will not identify you.
If you would like to receive a copy of the results you can let the research team know by emailing Amy.Peacock@unsw.edu.au, or you can opt to enter your email to receive the overall study results. We will only use these details to send you the results of the research.

9. **What if I want to withdraw from the research study?**

NATIONAL DRUG AND
ALCOHOL RESEARCH CENTRE

UNIVERSITY of
TASMANIA

ONLINE PARTICIPANT INFORMATION STATEMENT
Development of a scale to measure adult alcohol intoxication risk behaviours
Dr Amy Peacock

If you do consent to participate, you may withdraw at any time. You can do this by closing the questionnaire. If you withdraw from the research we will destroy any information that has already been collected. Once you have submitted the questionnaire however, we will only be able to withdraw your responses with the provision of your email address (if entered for future research participation or to obtain overall study results) or with the provision of your unique identifier if you opted to be contacted about the follow-up survey.

If you do consent to participate in the one month follow-up survey and provide a unique identifier to link your two surveys (you do not have to provide your name), you may withdraw at any time. You can email the research team (Amy.Peacock@unsw.edu.au) and tell them you no longer want to participate. If you decide to leave the research study, the researchers will destroy any information that has already been collected and no additional information will be collected from you. Your decision not to participate or to withdraw from the study, will not affect your relationship with UNSW Australia.

10. What should I do if I have further questions about my involvement in the research study?
The person you may need to contact will depend on the nature of your query. If you require further information regarding this study or if you have any problems which may be related to your involvement in the study, you can contact the following member/s of the research team:

Research Team Contact

Name	Dr Amy Peacock
Position	Research Fellow
Telephone	02
Email	Amy.Peacock@unsw.edu.au

What if I have a complaint or any concerns about the research study?
If you have a complaint regarding any aspect of the study or the way it is being conducted, please contact the UNSW Human Ethics Coordinator:

Complaints Contact

Position	Human Research Ethics Coordinator
Telephone	+ 61 2 9385 6222
Email	humanethics@unsw.edu.au
HC Reference Number	*16915*

NATIONAL DRUG AND
ALCOHOL RESEARCH CENTRE

UNIVERSITY of
TASMANIA

ONLINE PARTICIPANT INFORMATION STATEMENT
Development of a scale to measure adult alcohol intoxication risk behaviours
Dr Amy Peacock

Consent Form – Participant providing own consent

Declaration by the participant

- ☐ I understand I am being asked to provide consent to participate in this research study;
- ☐ I have read the Participant Information Sheet or it has been provided to me in a language that I understand;
- ☐ I provide my consent for the information collected about me to be used for the purpose of this research study only.
- ☐ I understand that if necessary I can ask questions and the research team will respond to my questions.
- ☐ I freely agree to participate in this research study as described and understand that I am free to withdraw at any time during the study and withdrawal will not affect my relationship with any of the named organisations and/or research team members;
- ☐ I would like to receive a copy of the study results via email or post, I have provided my details below and ask that they be used for this purpose only;
  Name: _____

  Address: _____

  Email Address: _____

- ☐ I understand that I can download a copy of this consent form from URL TO BE CONFIRMED

I agree, start questionnaire

Appendix C

Ethics Approval Letter HC16915

18-Mar-2019

Dear Dr Amy Peacock,

Project Title	Development of a scale to measure adult alcohol intoxication risk behaviours
HC No	HC16915
Re	Modification request dated 06.003.2019 seeking approval for the addition of a study site at the University of Tasmania. A personnel modification request form relating to this is provided for the addition of Tanya Wilson to the project.

The modification to this project was approved by the **HREC Executive** on **14-Mar-2019**.The following condition(s) must be met before data collection commences:

Modification conditions of approval:
N/A

The conditions of approval listed within the projects original approval letter still apply.

The **HREC Executive** Terms of Reference, Standard Operating Procedures, membership and standard forms are available from https://research.unsw.edu.au/research-ethics-and-compliance-support-recs.

If you would like any assistance, or further information, please contact the ethics office on:
P: +61 2 9 , + 61 2 or + 61 2 9
E: humanethics@unsw.edu.au

Kind Regards,

Prof Sean Emery
HREC Presiding Chairperson

This HREC is constituted and operates in accordance with the National Health and Medical Research Council's (NHMRC) *National Statement on Ethical Conduct in Human Research (2007)*. The processes used by this HREC to review multi-centre research proposals have been certified by the National Health and Medical Research Council.

Appendix D

Information and Consent Form HC16915

Refining the Monetary Choice Questionnaire

What is the research study about?

You are invited to take part in this research study. The research study aims to develop a shorter version of a questionnaire which we can use to measure personal preference for short term or long term rewards, and how this relates to alcohol consumption. You have been invited because you are aged 18 years or older, have consumed alcohol in the last 12 months, and have access to a phone or computer on which you can complete the internet-based survey.

Who is conducting this research?

The study is being carried out by the following researchers:

A/Prof Raimondo Bruno and Tanya Wilson, School of Medicine (Psychology), University of Tasmania

Dr Amy Peacock, National Drug and Alcohol Research Centre, University of New South Wales

Research Funder:This research is being funded by the University of Tasmania.

Inclusion/Exclusion Criteria

Before you decide to participate in this research study, we need to ensure that it is ok for you to take part. The research study is looking recruit people who meet the following criteria:

Are currently 18 years of age or older

Have consumed any alcohol in the last 12 months

Have access to a phone or computer on which they can complete the internet-based survey

Do I have to take part in this research study?

Participation in any research study is voluntary. If you do not want to take part, you do not have to. If you decide you want to take part in the research study, you will be asked to:

Read the information carefully (ask questions if necessary);

Complete the online questionnaire.

What does participation in this research require, and are there any risks involved?

If you decide to take part in the research study, we will ask you to complete an online questionnaire. The questionnaire will ask you questions about your preferences for short term and long term rewards, and your use of alcohol. It should take approximately 10 minutes to complete.

You can skip any items which you find distressing. We don’t expect this questionnaire to cause any harm or discomfort, however if you experience feelings of distress as a result of participation in this study you can let the research team know and they will provide you with assistance. Alternatively, you can call Lifeline (available 24 hours a day, 7 days a week, ph: 13 11 14); Counselling Online (http://www.counsellingonline.org.au/en/); or SANE (1800 18 7263 or http://www.sane.org/) to assist you if necessary.

What are the possible benefits to participation?

We hope to use information we get from this research study to benefit people working in drug treatment sectors to better assess risk of relapse in their clients using a briefer version of the reward scale we develop.

What will happen to information about me?

Submission of the online questionnaire is an indication of your consent. By commencing the survey you are providing your permission for the research team to collect and use information about you for the research study.

The survey will be administered via REDCap, a secure survey system and stored on servers owned and operated by the University of Tasmania.

Data will be stored in accordance with data management procedures of the University of Tasmania. Data files will be

password-protected and stored on secure UTAS servers. Access to the files (and the specific directories where the files are stored) will require a UTAS ID and password. Only those researchers named in the ethics application will have access to these directories.

We will store information about you in a de-identified format on a secure server. Your information will only be used for constructing a measure of risk-taking following alcohol use, and no individual data will be published. All electronic files on the UTAS server will be deleted after seven years.

How and when will I find out what the results of the research study are?

The research team intend to publish and/ report the results of the research study in a variety of ways. All information published will be done in a way that will not identify you.

If you would like to receive a copy of the results you can let the research team know by emailing Raimondo.Bruno@utas.edu.au.

What if I want to withdraw from the research study?

If you do consent to participate, you may withdraw at any time. You can do this by closing the questionnaire. If you withdraw from the research we will destroy any information that has already been collected. Once you have submitted the questionnaire however, we will not be able to remove your data as there is no identifying data being collected. Your decision not to participate or to withdraw from the study, will not affect your relationship with UTAS or UNSW Australia.

What should I do if I have further questions about my involvement in the research study?

The person you may need to contact will depend on the nature of your query. If you require further information regarding this study or if you have any problems which may be related to your involvement in the study, you can contact the following member/s of the research team:

A/Prof Raimondo Bruno, 03 6226 2240, Raimondo.Bruno@utas.edu.au

What if I have a complaint or any concerns about the research study?

This study has been approved by the Tasmania Social Sciences Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study, you can contact the Executive Officer of the HREC (Tasmania) Network on 03 6226 2975 or email ss.ethics@utas.edu.au The Executive Officer is the person nominate to receive complaints from research participants. You will need to quote H0018064.

If you consent to take part in the study, please start the questionnaire

Please enter your prolific ID	_____
What is your gender?	◯ Female ◯ Male ◯ Other
...how would you define your gender	_____
What is your current age (in years)?	_____
What state/territory do you live in?	◯ ACT ◯ NSW ◯ NT ◯ QLD ◯ SA ◯ TAS ◯ VIC ◯ WA
What is the highest level of education you have completed?	◯ Year 9 or below ◯ Year 10 or equivalent ◯ Year 12 or equivalent ◯ Trade certificate ◯ University degree ◯ Postgraduate degree

The following questions are about your preferences for immediate and delayed financial rewards. There are no right or wrong answers, we're just interested in your preferences!

Would you prefer....		
	$54 today	$55 in 117 days
1	◯	◯
	$55 today	$75 in 61 days
2	◯	◯

Appendix E

Ethics Approval Letter H0018073

UNIVERSITY of TASMANIA

20 May 2019

AssocProf Raimondo Bruno
C/- University of Tasmania

Sent via email

Dear AssocProf Bruno

REF NO: H0018073
TITLE: Validation of brief mobile/tablet based assessments of processing speed, inhibitory control and impulsivity

We are pleased to advise that acting on a mandate from the Tasmania Social Sciences HREC, the Chair of the committee considered and approved the above project on 09 May 2019.

Please ensure that all investigators involved with this project have cited the approved versions of the documents listed within this letter and use only these versions in conducting this research project.

This approval constitutes ethical clearance by the Tasmania Social Sciences HREC. The decision and authority to commence the associated research may be dependent on factors beyond the remit of the ethics review process. For example, your research may need ethics clearance from other organisations or review by your research governance coordinator or Head of Department. It is your responsibility to find out if the approvals of other bodies or authorities are required. It is recommended that the proposed research should not commence until you have satisfied these requirements.

In accordance with the National Statement on Ethical Conduct in Human Research, it is the responsibility of institutions and researchers to be aware of both general and specific legal requirements, wherever relevant. If researchers are uncertain they should seek legal advice to confirm that their proposed research is in compliant with the relevant laws. University of Tasmania researchers may seek legal advice from Legal Services at the University.

All committees operating under the Human Research Ethics Committee (Tasmania) Network are registered and required to comply with the *National Statement on the Ethical Conduct in Human Research* (NHMRC 2007 updated 2018).

Therefore, the Chief Investigator's responsibility is to ensure that:

(1) All investigators are aware of the terms of approval, and that the research is conducted in compliance with the HREC approved protocol or project description.

(2) Modifications to the protocol do not proceed until **approval** is obtained in writing from the HREC. This includes, but is not limited to, amendments that:

Human Research Ethics Committee (Tasmania) Network
Research Ethics and Integrity Unit
Office of Research Services

Private Bag 1
Hobart Tasmania
7001
Australia

T +61 3 6226 6254
E ss.ethics@utas.edu.au
ABN 30 764 374 782 /CRICOS 00586B
utas.edu.au

UNIVERSITY of TASMANIA

(i) are proposed or undertaken in order to eliminate immediate risks to participants;
(ii) may increase the risks to participants;
(iii) significantly affect the conduct of the research; or
(iv) involve changes to investigator involvement with the project.

Please note that all requests for changes to approved documents must include a version number and date when submitted for review by the HREC.

(3) Reports are provided to the HREC on the progress of the research and any safety reports or monitoring requirements as indicated in NHMRC guidance. Researchers should notify the HREC immediately of any serious or unexpected adverse effects on participants.

(4) The HREC is informed as soon as possible of any new safety information, from other published or unpublished research, that may have an impact on the continued ethical acceptability of the research or that may indicate the need for modification of the project.

(5) All research participants must be provided with the current Participant Information Sheet and Consent Form, unless otherwise approved by the Committee.

(6) This study has approval for four years contingent upon annual review. A *Progress Report* is to be provided on the anniversary date of your approval. Your first report is due 09 May 2020, and you will be sent a courtesy reminder closer to this due date. Ethical approval for this project will lapse if a Progress Report is not submitted in the time frame provided

(7) A *Final Report* and a copy of the published material, either in full or abstract, must be provided at the end of the project.

(8) The HREC is advised of any complaints received or ethical issues that arise during the course of the project.

(9) The HREC is advised promptly of the emergence of circumstances where a court, law enforcement agency or regulator seeks to compel the release of findings or results. Researchers must develop a strategy for addressing this and seek advice from the HREC.

Should you have any queries please do not hesitate to contact me on (03) 6226 6254 or via email ss.ethics@utas.edu.au.

Jude Vienna-Hallam
Executive Officer I Social Sciences

Human Research Ethics Committee (Tasmania) Network
Research Ethics and Integrity Unit
Office of Research Services

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Appendix F

Information and Consent Form H0018073

Participant Information Sheet V1 March 2019

Validation of brief mobile/tablet based assessments of processing speed, inhibitory control and impulsivity

Invitation

This is an independent study conducted by Associate Professor Raimondo Bruno, in the School of Medicine (Psychology) at the University of Tasmania. Other researchers involved in the study include Dr Matthew Gretton, who programmed one of the tasks, and Tanya Wilson, Edin Van Der Kley and Megan Young as part of their research for the degree of Honours in psychology.

1. What is the purpose of this study?

We have developed **three** new tests that can be used on mobile smartphones or tablets. They will look at processing speed, inhibitory control, and impulsivity. We want to make these freely available for other researchers and for clinical purposes. Before we can put these new tests out to be used, we need to make sure that the new tests on mobile phones/tablets work in the same way as pencil and paper-based and other versions of the tasks. We also need to make sure that they give a reliable measure of people's processing speed, inhibitory control and impulsivity – and by that we mean that it should give you similar results if you repeat the test. Once we have tested these, then we will be able to confidently use the new test in research studies and make them available for others to use.

Processing speed is basically a measure of how quickly your brain can deal with information and make decisions. For example, working out if something on a computer screen is an X or a Y; or seeing if there is a match among a group of images. Processing speed is an important part of cognition (thinking) because it is a skill that is necessary for performing well in a number of different areas. For example, how well you can work with information in working memory (such as doing maths problems in your head) depends on how quickly you can process information. This new test is based on a very well used task that is usually done with pencil and paper. We have made a new and harder version that works on mobile phones so that we can measure processing speed in real world contexts. In the future, we're hoping to use this task to do things like measure processing speed over the work day in people who work with complicated machinery; to measure processing speed over the course of an evening out while people are drinking alcohol; or over the course of attending music festivals.

Inhibitory control is how good you are at stopping responses once you've started. For example, like when you have started to move into a different lane while driving but suddenly notice a car in your blind spot, so you shift back into your original lane. The ability to do this skill is really important for a number of areas, but in particular things like being able to withstand cravings and staying abstinent when you're trying to stop smoking or drinking. The existing measures for this are good but both expensive and pretty boring for people to complete. We have developed a new measure that we hope is more interesting, based on the traditional 'whack-a-mole' game.

Impulsivity is about whether your decisions are focused on immediate reward or what is better for you in the long term. Like, for example, when you are hungry and need to choose between satisfying but unhealthy foods (like hot chips) and less satisfying but more health

foods (like fruit). We have made a short version of a questionnaire that asks about preferences for immediate vs long term rewards.

2. Why have I been invited to participate?

We're inviting any adults between 20 and 64 who are healthy and not taking any medications that are willing to help us validate these tasks.

We're not just asking people who are university students to take part, but if you are involved with the University of Tasmania, you should know that if you don't want to take part in this study, that is OK, and it is not going to have any impact on the way you are treated by the University. If you start taking part in this study, and decide that you don't want to continue, that's not going to have any impact on how the University will treat you either.

3. What will I be asked to do?

There's two parts to this study. Each part will take between 30 and 45 minutes.

After making sure that you are eligible to take part, you will be given some tests of cognition (thinking). These might ask you to pronounce some unusual words out loud (like 'yacht'), to pick the direction of an arrow on screen as quickly as possible, to work out whether there are matches in a group of images. Each of these are pretty short (2-4 minutes) and are designed to be tricky.

Then you will complete the three new tasks:

Processing speed: What you will need to do is to work out, as quickly as possible, if any of a group six images on screen are an exact match to either of two target images. There will be a lot of these trials, and about half of them will be matches and half of them won't match.

Inhibitory control: This is just like a game of 'whack-a-mole'. Here, different sorts of bottles will pop up on a screen, one at a time. As quickly as possible you have to smash any bottles of healthy drinks (like water or oange juice). Every now and then, a bottle of alcohol (beer or wine) will pop up, and you have to avoid hitting those ones. You will have around 100 trials to get as many points (for hitting the right targets) as possible.

Impulsivity: Here you just need to answer a bunch of 'would you rather'-type questions. For example, you might be asked "Would you prefer $54 today or $55 in 117 days?". All you have to do is pick whether you would, hypothetically, prefer to have the money today or to wait for the larger option. There are no 'right' or 'wrong' answers, we're just interested in your opinion.

You can take regular breaks (we'll remind you about this option).

About a week later, we'd like you to invite you to come back and do the same tasks again. This might seem a little pointless, but knowing how much people's performance changes after they have done the task is critically important if we are going to use the test in repeated studies.

It is important to know that it's up to you whether you want to do any of these bits of the study, and if you are only ok with some parts and not others, that's ok, you can still take part in the bits of the study that you are comfortable with.

4. Are there any possible benefits from participation in this study?

The main benefit from taking part in this study is making a contribution to science by making sure that the tests we use are valid.

We appreciate your time and inconvenience in contributing to research, and we are able to provide reimbursement of $10 for each of the sessions ($20 in total, paid once you've completed both parts). If you decide to do only one part, we will of course provide the amount of payment for the part you complete.

5. Are there any possible risks from participation in this study?

These tests are all designed to be challenging, but it is unlikely that you would find them stressful or that they would cause you to be upset. It might feel a bit annoying if you make a mistake but the tests are all designed to be challenging enough so that ***everybody*** is going to make mistakes somewhere.

We are going to keep your personal details confidential. The consent forms with identifying information (such as your contact details) are kept separately from all other information from this study (such as the questions about your substance use). They are stored securely at the University. All information from the study is stored only with a study ID (e.g. CTX777). As soon as you complete the study, any link between your identifying information and study ID is securely destroyed, making it very difficult for an individual person to be identified by their data.

6. What if I change my mind during or after the study?

As noted above, it is completely fine for you to decide not to answer any questions that you're not comfortable with. That won't affect your relationship with the University. The same applies if you start the study and then decide that it is not for you. You don't need to explain why. If you decide to withdraw, you will still receive reimbursement for your time involved in the study, on a pro-rata basis.

If you decide that you don't want to be part of the study, and you let us know before the end of your participation in the study, we'll be able to work out which data is yours and we can delete all records and securely destroy any consent forms. If you let us know after you have finished all the parts of the study, we won't be able to remove your data because we would have destroyed the links between your identifying information and the study ID.

7. What will happen to the information when this study is over?

Identifying information will be destroyed as soon as any individual participant completes their part of the study. All the information about performance on the different tasks are stored only using study ID. This will be stored in an electronic database, on secured University of Tasmania servers, and password protected. Hard copies (of your consent form with no link to a study ID) are stored in locked filing cabinets in University of Tasmania storage archives. Both electronic and hard copy data will be destroyed five years after the first publication from this study.

A reminder: any information obtained for the purpose of this study that can identify you will be destroyed as soon as you have completed your part in the study or withdrawn your consent. All information, regardless of whether it is identifying or not, will be treated as confidential and always securely stored.

The data from the tests doesn't provide any useful diagnostic information – it is mainly just information about reaction times. Where it is used in research is to test for *changes* as people get tired, or consume alcohol, or are prescribed medications and the like. Because of this, we are not planning on providing any feedback about your performance to you.

8. How will the results of the study be published?

Study findings will be presented in formal publications and in conference presentations. Only group level analyses will be reported, so there is no way that a particular individual could be identified in any publication. The results will be available on the university of Tasmania publications repository, WARP (https://rmdb.research.utas.edu.au/public/rmdb/q/warp_home) or specifically here: https://rmdb.research.utas.edu.au/public/rmdb/q/indiv_detail_warp_trans/3812#research-tab-5. You can also contact Raimondo Bruno directly here: Raimondo.Bruno@utas.edu.au

9. What if I have questions about this study?

If you have questions about the study, you can contact Raimondo Bruno at 03 6226 2240 or Raimondo.Bruno@utas.edu.au.

This study has been approved by the Tasmanian Social Sciences Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study, please contact the Executive Officer of the HREC (Tasmania) Network on +61 3 6226 6254 or email human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. Please quote ethics reference number H0018073.

Thank you for your interest in the study, and your time in reading this information sheet. This is for you to keep. If you want to take part in this study, there is a consent form for you to complete. This will be stored separately from the test results.

Researcher's institutional letterhead

Participant Consent Form V1 March 2019

Validation of brief mobile/tablet based assessments of processing speed, inhibitory control, and impulsivity

Consent form for participants

1. I agree to take part in the research study named above.
2. I have read and understood the Information Sheet for this study.
3. The nature and possible effects of the study have been explained to me.
4. I understand that the study involves completion of a number of brief tests, on computers, and pencil and paper, of my thinking.
5. I also understand that I will be asked to come to a second session to repeat these tasks, in order to measure how test performance holds up over time.
6. I understand that participation involves no foreseeable risks.
7. I understand that all my data will be labelled only with a study ID, not my name or any other identifying information, and that any link between my name and Study ID will be destroyed as soon as I have completed my role in the study, whether that be by completion of both sessions or decide to discontinue for any other reason.
8. I understand that all research data will be securely stored by study ID only on the University of Tasmania premises for five years from the publication of the study results, and will then be securely destroyed.
9. Any questions that I have asked have been answered to my satisfaction.
10. I understand that the researcher(s) will maintain confidentiality and that any information I supply to the researcher(s) will be used only for the purposes of the research.
11. I understand that the results of the study will be published so that I cannot be identified as a participant.
12. I understand that my participation is voluntary and that I may withdraw at any time without any effect.

    I understand that I will not be able to withdraw my data after completing all parts of the study, as any links with identifying information will have been destroyed. Before this point, I am able to withdraw my data if I so wish.

Participant's name: _____

Participant's signature: _____

Date: _____

Statement by Investigator

☐ I have explained the project and the implications of participation in it to this volunteer and I believe that the consent is informed and that he/she understands the implications of participation.

If the Investigator has not had an opportunity to talk to participants prior to them participating, the following must be ticked.

☐ The participant has received the Information Sheet where my details have been provided so participants have had the opportunity to contact me prior to consenting to participate in this project.

Investigator's name: _____

Investigator's signature: _____

Date: _____

Appendix G

Ethics Approval H0016125

From: Human.Ethics@utas.edu.au <Human.Ethics@utas.edu.au>
Sent: Monday, May 6, 2019 10:22 AM
To: Raimondo Bruno
Cc: Amy.Peacock@unsw.edu.au; Olivia.Maynard@bristol.ac.uk; Jane Akhurst; E.Kuntsche@latrobe.edu.au; A.Pennay@latrobe.edu.au; Thomas Norman; Megan Young; Erin Van Der Kley; Tanya Wilson
Subject: Notification of Amendment Approval: H0016125 Longitudinal Study on Alcohol, Harm and Cognitive Perfo

Dear AssocProf Bruno,

Ethics Ref: H0016125
Title: Longitudinal Study on Alcohol, Harm and Cognitive Performance in the Festival Environment

This email is to confirm that the following amendment was approved by the Executive Officer on behalf of the Tasmania Health and Medical Human Research Ethics Committee on 6/5/2019:

Amendment Additional Staff: Erin Van Der Kley, Megan Young, Tanya Wilson
Information Sheet PITP Information Sheet - Apr2019

All committees operating under the Human Research Ethics Committee (Tasmania) Network are registered and required to comply with the National Statement on Ethical Conduct in Human Research (NHMRC 2007).

This email constitutes official approval. If your circumstances require a formal letter of amendment approval, please let us know.

Should you have any queries please do not hesitate to contact me.

Kind regards

Gina Zappia
--
Ethics Officer
Office of Research Services
University of Tasmania
Private Bag 01
Hobart TAS 7001

Email: Human.Ethics@utas.edu.au
http://www.utas.edu.au/research-admin/research-integrity-and-ethics-unit-rieu

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Research Integrity. The University of Tasmania is dedicated to creating and maintaining an environment that promotes the responsible and ethical

Appendix H

Information and Consent Form H0016125

School of Medicine
University of Tasmania

Information Sheet

Alcohol Intoxication, Transdermal Alcohol Assessments and Cognitive Performance

Version 4, April 2019

Introduction
You are invited to participate in a study examining the relationship between transdermal alcohol assessments, cognitive performance and alcohol intoxication. This research is being conducted by Thomas Norman, as partial fulfilment of a Doctor of Psychology degree. Thomas is being supervised by Associate Professor Raimondo Bruno and Dr Amy Peacock from the School of Medicine (Psychology), University of Tasmania. In addition, this research will be part of the research conducted by Erin van der Kley, Megan Young and Tanya Wilson for their Honours in Psychology. The key researchers can be contacted as following: Thomas Norman (Thomas.Norman@utas.edu.au) or Raimondo Bruno (Raimondo.Bruno@utas.edu.au).

What is the purpose of the study?
The purpose of this study is to investigate the degree to which transdermal alcohol concentration relates to alcohol intoxication and cognitive performance (e.g., reaction time, accuracy, decision-making,) outcomes.

Who can participate?
We are currently seeking participants who are:

- Male or female
- Aged 18 years or over
- Completed Year 12
- Normal or corrected-to-normal vision
- Normal sleep patterns
- Healthy (no history of significant neurological disorder or current psychiatric disorder, significant intellectual disorder, alcohol/drug dependence, regular tobacco use, or chronic health problems)
- Regular alcohol consumers (minimum consumption of 2 standard alcoholic drinks on one occasion in the preceding month)
- Not currently using illicit drugs (i.e., use in the preceding six months)

- Able to attend the Hobart campus of the University of Tasmania for one three hour session conducted between 9am and 7pm.

What does participation in the study involve?
This research will be conducted in the Perception Laboratory at the School of Psychology, University of Tasmania (Hobart). Interested individuals will complete a brief screening questionnaire that collects data about demographics (e.g., age, sex), medical history, pregnancy/breastfeeding status (females only), psychological wellbeing, reading ability, use of alcohol and other drugs. Eligible participants will be asked to attend one three hour session at the psychopharmacology laboratory.

If participants are deemed eligible, they will be invited to participate in a laboratory session. During this session, participants will be dosed with alcohol (up to .05 breath alcohol concentration) and asked to complete a series of cognitive tasks on a tablet. A breathalyser will be used to monitor participants' breath alcohol concentration throughout the duration of the study. They will be fitted with a continuous alcohol monitoring bracelet around their ankle, which will be worn during the course of the session and taken off before they leave. This bracelet can be taken off at any time if the participant wishes to do so. Session length is dependent on the time taken for the participant to record two consecutive breath alcohol readings of .03% or less (.00% for Provisional licence holders intending to drive). Depending on the individual's rate of alcohol absorption and elimination this time may vary and therefore some sessions may take longer than three hours to complete.

What are the restrictions regarding participating?
Participants will be asked to abstain from alcohol and over-the-counter medication for 24 hours prior to the laboratory session. Participants will be asked to abstain from illicit drugs and tobacco for the duration of participation.

At the end of the laboratory session, participants will remain at leisure (with food and entertainment provided) until they attain two consecutive breathalyser recordings of 0.03% or less measured 15 minutes apart.

Participants holding their provisional driver licence, who are intending to drive will be required to remain in the laboratory until two consecutive BrAC measurements are recorded at .00%. Participants holding their provisional licence who are not intending to drive, will be able to leave the laboratory at .03% BrAC if they sign a declaration in which they agree to be escorted by a nominated guardian to their place of residence and accompanied for a two hour period following session completion. The nominated guardian must be an adult aged 18 years or older who: (i) holds their provisional or full driver licence (ii) directly collects the participant from the research premises and meets the researcher in-person, and (iii) signs a declaration agreeing to escort the participant directly to their place of residence and accompany the participant for the two hour period following session completion. The researcher reserves the right to retain participants in the laboratory until .03% BrAC for those holding their full driver licence and .00% BrAC for those holding their provisional licence when it is deemed unsafe for the participant to leave at .03% BrAC.

What are the benefits of participating?
Your participation will help us enhance our knowledge of the effects of alcohol on transdermal readings and on cognitive performance outcomes. This knowledge can be used to help educate people and the scientific community regarding the potential outcomes and utility of these measures in alcohol-related research.

What are the risks associated with participating?
There are no anticipated risks of this research. However, if in the unlikely event you experience negative side-effects, please inform the experimenter and the necessary assistance will be sought and provided. We ask that participants refrain from consuming alcohol or operating heavy machinery for four hours post-laboratory session.

Is there any monetary reimbursement for participation?
Participants will be reimbursed $50 for participation in the session.

How do I volunteer to participate? What if I want to withdraw from participating?
Participation in this study is voluntary. By signing the attached consent form, you are indicating that you are aware of the nature of the study and wish to participate. While we would be pleased to have you participate, we respect your right to decline. There will be no consequences to you if you decide not to participate. If you decide to discontinue participation at any time, you may do so without providing an explanation. However you will be required to remain in the laboratory until your breath alcohol concentration measurement equals 0.03% or less on two separate occasions measured 15 minutes apart.

What will happen to the information I provide?
All information collected will be kept confidential. Each participant will be assigned a code and individual participant data will be identifiable only by that code. All of the data will be stored on password protected secure computers or in a locked cabinet in the School of Psychology for a minimum of five years after the publication of any academic journal articles, at which point all questionnaires will be destroyed using a paper shredder and electronic data will be deleted. The screening questionnaire will be securely destroyed immediately on completion of the study and that any information provided by the participant on the questionnaire will be identifiable only by participant number, kept confidential, and viewed only by the experimenter.

Who do I contact if I have any queries?
If you would like to discuss any aspect of this study please contact Thomas Norman (Thomas.Norman@utas.edu.au). Alternatively, you can contact Dr Raimondo Bruno on (03) 6226 2240 or email Raimondo.Bruno@utas.edu.au.

How do I find out the results of the study?
A summary of the results will be available on the Research webpage of the School of Psychology, University of Tasmania (http://fcms.its.utas.edu.au/scieng/psychol/). Results of the study can also be provided by Thomas Norman (Thomas.Norman@utas.edu.au).

Who do I contact if I have a complaint about the study?
This study has been approved by the Tasmanian Social Science Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study should contact the Executive Officer of the HREC (Tasmania) Network on (03) 6226 7479 or email human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. You will need to quote H0016125.

Who do I contact if I wish to speak to someone about my alcohol or drug use, or mental health?
As aforementioned, a number of simple screening questionnaires will be administered assessing psychological functioning and alcohol and other drug use. Whilst it is not anticipated that these questionnaires will cause distress, please do not hesitate to let the researcher know if you do not wish to fill them in. If you are concerned about your drinking or mental health, please contact the Tasmanian Alcohol Drug Information Service 1800 811 994 or Lifeline 13 11 14 (both services available 24 hours a day).

Thank you for taking the time to consider this study.
If you wish to take part in it, please sign the attached consent form.
This information sheet is for you to keep.

Version 3, March 2019

School of Psychology
University of Tasmania

Consent Form

Alcohol Intoxication, Transdermal Alcohol Assessments and Cognitive Performance

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1. I have read and understood the 'Information Sheet' for this project.
2. The nature and possible effects of the study have been explained to me.
3. I understand that the study involves attending the Cognitive Neuroscience Laboratory for one three hour session. This can be completed on a mutually convenient day of your choosing.
4. I understand that my height, weight, reading ability, psychological wellbeing, demographic information, drug and alcohol use history and pregnancy/breastfeeding status (females only) will be assessed to ensure my eligibility for participation. I understand that in the session I will complete measures of cognitive performance and alcohol use, as well as having my height and weight measured.
5. I understand that I will be asked to sign a declaration and complete a breath alcohol concentration measurement (via a breathalyser) to confirm my abstinence at the start of the laboratory session.
6. I understand that in the laboratory session I will receive a beverage containing alcohol. I understand that I will be given enough alcohol to receive a breath alcohol reading of .05. I understand that after beverage consumption, I will be asked to complete a number of laboratory cognitive-behavioural performance tasks during which my behavioural responses will be recorded. I understand that my breath alcohol concentration will be recorded throughout the laboratory session.
7. I understand that I will be asked to remain in the laboratory until my blood alcohol concentration equals 0.03% or less on two occasions measured 15 minutes apart. I acknowledge that I have been advised to refrain from drinking alcohol or operating a vehicle or other heavy machinery for four hours after the end of the experimental session.
8. I understand that if I hold a provisional driver licence and I intend to drive I will be required to remain in the laboratory until my breath alcohol concentration is .00% on two consecutive occasions. I understand that if I hold a provisional driver licence and do not intend to drive I will be able to leave the laboratory at .030% BrAC after signing a declaration in which I agree to be escorted by my nominated legal adult to my place of residence and be accompanied for a two hour period following session completion. I understand that the

nominated legal guardian must be an adult aged 21 years or older who: (i) holds their provisional or full driver licence (ii) directly collects me from the research premises and meets the researcher in-person, and (iii) signs a declaration agreeing to escort me directly to my place of residence and accompany me for the two hour period following session completion. Furthermore, I understand that the researcher reserves the right to retain participants in the laboratory until .03% BrAC for those holding their full driver licence and .00% BrAC for those holding their provisional licence when it is deemed unsafe for the participant to leave at .03% BrAC. I acknowledge that I have been advised to refrain from drinking alcohol or operating a vehicle or other heavy machinery for four hours after the end of experimental sessions.

9. I understand that I will be fitted with a continuous alcohol monitoring bracelet during the sessions, but that I may take this off at any time and for any reason.

10. I understand that I will be provided reimbursement to the sum of $50 for participation. If I withdraw from the study prior to concluding all sessions I will not be eligible for monetary reimbursement, unless the withdrawal is due to an unexpected adverse event.

11. I understand that, while there are no anticipated risks associated with this study, I should inform the experimenter immediately if any unexpected negative side-effects are experienced. I understand the experimenter will immediately cease the session and seek the necessary assistance. I understand that I can contact the researchers, Lifeline or the Tasmanian Drug Information Service should I experience any adverse (phone numbers have been provided on the information sheet).

12. I understand that the researchers will maintain my confidentiality and that any information I supply to the researcher(s) will be used only for the purposes of the research. My data will only be identifiable by an individual numerical participant code.

13. I understand that the screening questionnaire will be securely destroyed immediately on completion of the study and that any information I provide will be identifiable only by my participant number, kept confidential, and viewed only by the experimenter.

14. I understand that all research data will be securely stored on the University of Tasmania premises for at least five years, and will then be securely destroyed when no longer required.

15. I agree that research data gathered from me for the study may be published provided that I cannot be identified as a participant.

16. I agree to participate in this investigation and understand that I may withdraw at any time without any effect, and if I so wish, may request that any data I have supplied to date be withdrawn from the research.

17. Any questions that I have asked have been answered to my satisfaction.

Name of Participant _____

Signature of Participant _____

Date _____

Statement by Investigator

I have explained the project & the implications of participation in it to this volunteer and I believe that the consent is informed and that he/she understands the implications of participation.

If the Investigator has not had an opportunity to talk to participants prior to them participating, the following must be ticked. ☐

The participant has received the Information Sheet where my details have been provided so participants have the opportunity to contact me prior to consenting to participate in this project. ☐

Name of Investigator _____
Signature of Investigator _____
Date _____

Appendix I

Non-covariate Adjusted F-tests Between Delay Discounting and Alcohol Intoxications

Table x.

Statistics from ANCOVA controlling for BMI

	Timepoint * Sex				Timepoint				Sex			
Model	F	df_1	df_2	*p*	F	df_1	df_2	*p*	F	df_1	df_2	*p*
Full MCQ	0.18	2	37.9	.836	1.54	2	37.9	.228	4.64	1	35.1	.038
Medium Category	1.17	2	38.2	.320	0.16	2	38.2	.854	4.49	1	35.4	.041
Large brief	0.93	2	40.0	.402	1.07	2	40.0	.353	4.85	1	34.2	.034
Composite 7	0.12	2	41.8	.884	0.84	2	41.8	.441	4.89	1	52.7	.031